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VOL. XII, No. 1. WASHINGTON JANUARY, 1901

THE NATIONAL GEOGRAPHIC MAGAZINE

THE INFLUENCE OF SUBMARINE CABLES UPON MILITARY AND NAVAL SUPREMACY

BY GEORGE O. SQUIER, CAPT. SIGNAL CORPS, U. S. A.

THE accidental non-delivery of two cable messages from the Minister of Marine (Bermejo) to the Commander-in-Chief of the Spanish Squadron (Cervera) at Martinique, undoubtedly largely changed the whole history of the Spanish-American War.

One of these telegrams informed him of coal supply near at hand, and the other granted him permission to return at once, with his squadron, to Spain.

Admiral Cervera's firm stand against the despatch of the Spanish squadron from the coast of Spain to West Indian waters is heroically and almost pathetically shown in the recent publication, by permission of the Queen Regent, of the official despatches. At Cape Verde, and before and after, by cable and by letter, he points out the unpreparedness of his squadron, and predicts its certain destruction if it proceeds. Knowing his strong views, it is probable that he would have lost no time in coaling and starting back to Spain.

With Cervera's squadron returned to Spain there would have been no Santiago campaign, the Flying Squadron would probably have been sent to the coast of Spain, and the land operations in Cuba directed against Havana.

Cervera's fleet not eliminated, who can say how long Spain may not have been able to resist, and what additional blood and treasure the struggle may have cost the United States.

The story of the Spanish-American War is largely a story of "coal and cables." That war for the first time demonstrated the dominating influence of submarine cable communications in the conduct of a naval war. As a result of it the principal maritime powers, with colonial possessions, are each at present elaborating their "cable policy," and have awakened to a realization of the fact that reliable submarine communications under exclusive control are not only absolutely necessary, but exercise a dominating influence upon the control of the seas, whether in commercial strategy or in military and naval strategy.

A modern war between two naval powers has reduced itself largely to a war of "coal and cables."

At present the submarine telegraph is

a powerful instrument of war, more powerful, indeed, than battleships and cruisers, since by its wonderful and instantaneous communications of thought, it brings distant countries and colonies together in sympathy, which is the only true and permanent tie.

ELECTRICITY THE IDEAL MEANS OF TRANSMITTING INTELLIGENCE.

The triumphs of science in the last half century have been nowhere more exemplified than in the enormous strides made in the facility of transmitting intelligence. The mails, the telegraph, and the telephone are civilizing the world. Perfect as is the mail system of to-day, a monument to organization, yet its swiftest messenger—steam—is so far outstripped, either on land or sea, by the practically instantaneous electric current, that the tendency, year by year, is to put more of the world's business " upon the wire."

Time has an international money value in trade, and a paramount strategic value in war. The fastest mail express, or the swiftest ocean ship, are as naught compared with the velocity of the electrical impulse which practically annihilates any terrestrial dimension. As the distance increases, electricity surpasses steam in a continuously increasing ratio. A message is to be sent half way around the earth; the minutes required by the telegraph run into weeks and months by the slow process of the mails. Steam time is directly a function of the distance to be traversed, and from the nature of things is twice as long for two miles as for one. If, then, the cable saves six days between Europe and America, it will save more than twice this time between America and the East, and is, from this point of view, correspondingly important and necessary. Since electricity so far outstrips any other known vehicle for transmitting intelligence, it must eventually carry all the most important of the world's information.

Strategy has been defined as " the science of combining and employing the means which the different branches of the art of war afford, for the purpose of forming projects of operations and of directing great military or naval movements; the art of moving troops or ships so as to be enabled either to dispense with a battle or to deliver one with the greatest advantage and with the most decisive results."

It is believed that the more the foundations of successful strategy are analyzed, both as the science of conceiving military plans and as an art of executing the same, the more it will become clear that the strategist who is possessed of the most efficient and reliable means of obtaining and communicating information, both of the enemy and his own forces, will have a paramount and insuperable advantage.

Maritime nations are at present beginning to realize that it is not ships and coaling stations alone which measure maritime strength, but also reliable and efficient means of directing, concentrating, supplying, or withdrawing those ships upon the great chess-board of the sea.

As a means of communication over great distances at sea nothing compares, at the present state of practical science, with the submarine cable. The nation with exclusively controlled submarine communications, not possessed by an adversary, has an organized service of surveillance which is not only important during actual war, but which may and will prove a powerful weapon in the diplomatic and preparatory conflict which always precedes a declaration of war, and these communications are a means of securing a first *real* victory, even before war has been formally declared.

It may be said, therefore, *that the very foundation of successful naval strategy is efficient and exclusively controlled communications, and the lack of them more serious than inferior ships.*

THE IMPERIAL CABLE SYSTEM OF GREAT BRITAIN.

As soon as the possibility of communicating at long distance, by means of submarine cables, was practically demonstrated, England saw what commercial and political preponderance the creation of a great network of cables, resting under her control, would give her. Without letting herself be discouraged by heavy losses in the beginning, with a perseverance worthy of admiration, she has succeeded in creating and developing, methodically and without delay, a network of submarine telegraphic cables, which to-day encircles a large part of the entire world.

The English cables, up to the present, have been laid principally by private companies, but Article 7 of the conditions which govern them provides that all official despatches shall have precedence over others; Article 3, that the companies can have no foreigners among their employees, nor can the wires pass into a foreign office, nor under the control of a foreign government; and Article 9, that in case of war the government can occupy the different stations and place its own employees therein.

During the past two years, however, there has been a great national protest in England and the colonies against the exorbitant rates imposed by the monopoly of the private cable corporations, until the principle of absolute state ownership has come to be a controlling one in England's future cable policy.

England's sea-power is not alone measured by the number, character, and tonnage of her war-ships. It is immensely increased by the system of exclusively controlled submarine cable network, which at present forms four-fifths of all the cables in the world, woven like a spider's web to include all her principal colonies, fortified ports, and coaling stations.

Submarine cable communication is scarcely fifty years old, yet the British Empire is already bound together in one vast intelligence, transmission system, with London as its centre. Nothing important can happen in any quarter of the globe which does not find its way to this great world's news exchange—London. And this system is and has been a principal element of her strength and has largely made possible a government including subjects naturally widely differing in character, habits, and modes of thought.

This great cable system is the more important since no other country has such a system, and this fact has placed in the hands of the British Empire a powerful means of real dominion over the rest of the world. Nor is England satisfied with her present extensive telegraph system of world control; she has in projection for the very near future an extension of this system, which will be nothing less than a British imperial telegraph system encircling the entire globe.

It was early discovered by every country in Europe that so efficient and valuable a servant to trade and commerce, so important an aid to the state itself as the telegraph, should become a national institution. Great Britain, France, Austria, Prussia, Russia, Sardinia, Italy, Spain, Portugal, and Belgium, each established a state telegraph system. Thirty years ago the English telegraph lines were transferred to the state, and experience has shown that this has been done with advantage to the state itself and to the benefit of the public. At the present moment the British Empire is advancing rapidly to the accomplishment of a state controlled cable system. Imperial penny-postage having been recently realized throughout the British Empire, the next great step in imperial development along this line is to connect the state-owned land telegraph systems of the Empire by a state-owned and controlled system of submarine cables.

An essential and necessary condition

which has guided in the conception and realization of this cable system has been that none of the lines shall touch foreign soil. So important has been this principle in the proposed British-Pacific cable that we find Great Britain, for some years past, anxiously negotiating for sovereignty over an insignificant island in the Hawaiian group upon which to land her proposed cable to Australasia; and, failing in this, we find her boldly ready to lay a single span of cable of over 3,500 nautical miles in length from Vancouver to Fanning Island, for the sole imperial reason that the cable shall touch only soil exclusively owned and controlled by Great Britain. This principle will be bought in this case at the price of permanently placing at a disadvantage British cable traffic in the Pacific; since, as will be pointed out later, the United States, by the annexation of the Hawaiian Islands, can reach the East across the mid-Pacific by cables having no single span longer than the present Atlantic cables, and yet adhere to the same principle of landing only on territory belonging to the United States.

BRITISH-PACIFIC CABLE.

England at present has direct telegraphic connection with Vancouver with wires independent of any foreign power. Practically all of the Atlantic cables landing at Newfoundland or Nova Scotia from the coast of Ireland are under British control, and, in connection with the Canadian Pacific telegraphic lines, therefore furnish England with direct communication to the west coast of North America.

The proposed British-Pacific cable has been prominently before the British Government as an imperial measure for a number of years. It has been the subject of colonial conferences and of exhaustive research by a Pacific Cable Commission. Its construction is now assured beyond a reasonable doubt. The route from Vancouver is to Fanning Island, thence to Fiji Island, thence to Norfolk Island, and from thence by two branches to New Zealand, and the eastern coast of Australia. The land lines of Australia would then complete telegraph connection with the western coast.

In the Indian Ocean it is proposed to connect West Australia to Cocos Island, and thence to Mauritius, and from thence to Natal and Cape Town. Cocos Island is further to be connected with Singapore by a branch cable. Singapore is already in connection with Hong Kong by an all-British cable. Another branch is also proposed from Cocos Island to Ceylon. At Mauritius a connection would be formed with the existing cable at Seychelles, Aden, and Bombay. In the Atlantic Ocean, in order to avoid the shallow seas along the west coast of Africa, Spain, Portugal, and France, a cable from Cape Town, touching at St. Helena, Ascension, and mid-ocean stations, and extending to Bathurst, which is already connected by existing cables to Gibraltar, has been laid within the last few months. Its construction was hastened after the outbreak of the Boer war to furnish an alternate British route to South Africa by the West Coast. It is further proposed to extend the cable from Ascension to the British Island of Bermuda, perhaps touching at Barbados as a mid-ocean station. At Bermuda a connection would be formed with the cable already existing at Halifax, and that point with the Canadian and trans-Atlantic lines. The extension of the above cables in the Pacific, the Indian, and the Atlantic oceans would involve the expenditure of something like £6,000,000 sterling and the laying of about 23,000 knots of new cable. With the equipment and experience which Great Britain has had in cable-laying, these new cables can be manufactured and laid by England in an incredibly short time, and there can be little doubt but that this extension of British cables, if not along the exact line above specified, yet with slight variations

will be an accomplishment of the near future.

With this extension of imperial cable added to her already extensive state-owned land-line system, England will have the most complete telegraphic system in existence, placing the following fortified and garrisoned coaling stations in direct connection each with any other, viz.: Hong Kong, Singapore, Trincomalee, Colombo, Aden, Cape Town, Simons Bay, St. Helena, Ascension, Saint Lucia, Jamaica, Bermuda, Halifax, Esquimalt, King George's Sound, and Thursday Island. The following "defended ports" would likewise be connected, viz.: Durban, Karachi, Bombay, Madras, Calcutta, Rangoon, Adelaide, Melbourne, Hobart, Sydney, Newcastle, Brisbane, Townsville, Auckland, Wellington, Lyttelton, and Dunedin.

With the completion of the cable across the Pacific the last telegraphic gap will be completed around the earth. Great Britain will then have the great advantage of duplicate routes, since from any point there will be two routes—one east and one west—to any other station.

PROPOSED COLONIAL TELEGRAPH SYSTEM FOR THE UNITED STATES

Since the events of the Spanish-American War the supreme importance of exclusively controlled communications, as a means of military and naval warfare, has been recognized as never before. All the principal nations are studying this subject in its various aspects, and already a distinct cable policy is entering into the politics of the principal countries possessing colonies and seeking for commercial, military, and naval supremacy.

In this connection it may be of interest to note briefly what has been the telegraph policy of the United States in dealing with the territory of our new possessions. In Cuba and Porto Rico, and in the Philippine Archipelago, every effort has been made by the Signal Corps of the Army to cover the islands with a network of wires, so complete and reliable that intercommunication is insured at all times. In the pacification of Cuba and Porto Rico, in the suppression of the Philippine uprising, it is believed that there has been no more potent agent than the military telegraph.

For years Spain had been trying to pacify the Island of Cuba, and yet her telegraph system was incomplete, obsolete, and unreliable in the extreme. It was possible for bands of insurgents to move about much at their pleasure, appearing here and there, with no means of locating or concentrating for their destruction. It was not that the number of troops was not sufficient, so much as that there were no efficient means of directing the troops in such a way as to make results decisive.

TELEGRAPH SYSTEM IN CUBA AND PORTO RICO.

Since the evacuation of Cuba by Spanish troops the land telegraph system has been entirely reconstructed by the United States Signal Corps, and now aggregates about 2,500 miles, including a central trunk line the entire length of the island, which is duplicated from Havana to Sancti Spiritus. In addition to this trunk line there are thirteen lines across the island, which divide it up into comparatively small sections. Every mile of these lines has been reconstructed, under great difficulties, yet their reliability is evidenced by the fact that the entire Porto Rican Government business, which is now transmitted over the new land lines from Havana to Santiago, was conducted during the month of June, 1900, without a single interruption.

In the Island of Porto Rico every important commercial or military point is in telegraph connection by a system of lines, which have also been entirely reconstructed and the routes improved since the disastrous hurricane of August, 1899.

PHILIPPINE MILITARY TELEGRAPH SYSTEM.

It has been assumed as a principle from the outset that the quickest means of pacifying and civilizing the Philippine Archipelago is to cover it with a network of telegraph wires. Commanding officers can crush an incipient uprising suddenly and before it has time to assume dangerous proportions by concentrating by telegraph the garrisons from all directions upon the one point involved. Already there are about 2,500 miles of land telegraph lines in operation in the Philippines, and about two hundred and sixty miles of inter-island and lake cables have been laid, every mile constructed by the United States Signal Corps since the battle of Manila Bay. At the last report the telegraphic messages in the Island of Luzon alone exceeded 6,500 per day, averaging over forty words each, or approximately 260,000 words daily.

It may be added that the telegraph is practically the only mail service that exists.

In Luzon two trunk lines have been established—one along the west coast, the other along the Rio Grande de Cagayan. The islands of Cebu and Leyte have been connected by cable, and a complete new route from Manila to Iloilo is in operation, furnishing a duplicate route to the present English cable direct from Manila to Iloilo. In the Department of Mindanao and Jolo, the plan involves direct communication, by cable, between the principal islands, and by land lines and cable to the telegraph system in the Department of the Visayas, and from thence, by duplicate routes to Manila.

THE ALASKAN TELEGRAPH SYSTEM.

The growing commercial importance of Alaska, and the prospective future of that country, have made the construction of a telegraph system for this territory an imperative necessity. Congress at its last session authorized an expenditure of $450,000 for the construction of such a line.

Owing to the shortness of the working season in this latitude, and the very unusual conditions under which the line must be constructed, as well as the lack of any adequate transportation, it was not hoped to complete the work this season.

The military cables connecting the gold district of Cape Nome with the Headquarters at St. Michael, and also connecting St. Michael with Unalaklik, which is to be the terminus of the land line up the Yukon, have been completed and have placed the Department Commander at St. Michael in direct communication with Cape Nome.

These submarine cables, involving in the aggregate nearly two hundred miles, were constructed by an American manufacturer, and were laid, equipped, and operated by American engineers.

The military forts to be connected, with the approximate distances, are shown in the following table:

	Valdez.	Fort Egbert.	Circle City.	Fort Yukon.	Rampart.	Fort Gibbon.	St. Michael.
Fort Egbert ..	350						
Circle City. ..	520	170					
Fort Yukon...	610	260	90				
Rampart	870	520	350	260			
Fort Gibbon..	940	590	420	330	70		
St. Michael...	1,490	1,140	970	880	620	550	
Cape Nome ..	1,610	1,260	1,090	1,000	740	670	120

By a recent temporary arrangement with the Canadian authorities this telegraph system will be enabled to reach the United States over the line now being constructed by the Canadian Government between Atlin and Quesnelle—a distance of about nine hundred miles.

A PACIFIC CABLE.

In order to bind together the local land telegraph systems which have been outlined above, these systems should be directly connected at an early date with the United States. First in this colonial system, comes the proposed trans-Pacific Cable, connecting California with the Hawaiian Islands, thence to Midway

Island, thence to the Island of Guam, and from there to the Island of Luzon.

A cable system from Vancouver via the Aleutian Islands to Japan and the Philippines has long been proposed, and has many points, commercial and technical, in its favor as a trans-Pacific route. The true solution is thought to be the early construction of both of these trans-Pacific cable lines, thereby furnishing, first, a direct connection to the Alaskan system, and by a later extension to the Philippines a duplicate route for the protection of the more southern line via Hawaii. A short cable from Sitka to Valdez would be one means of perfecting a junction with the Alaska land system.

The recent acquisition by the United States of the island of Tutuila, and the construction in Pago Pago Harbor of a coaling station, makes it desirable to join this advanced American station in the southwestern Pacific to the Hawaiian Islands by submarine cable.

This can probably be most readily accomplished by connecting it directly to Fiji, a station on the British-Pacific cable route.

To further complete this proposed colonial telegraph system, it will be necessary to connect the island of Porto Rico by submarine cable to the United States, and, although of greater length, a line direct from New York to Porto Rico is suggested as offering many advantages. The shortest line is not always the most advantageous. For instance, Haiti is connected direct to New York City, instead of to the coast of Florida, which would be much nearer, and Bermuda is connected direct with Halifax, for the sole object of exclusive British control under all circumstances.

ESTIMATED COST OF PROPOSED COLONIAL TELEGRAPH SYSTEM.

CABLES IN THE PACIFIC.

Trans-Pacific cable, San Francisco via Hawaiian Islands, Midway Island, and Island of Guam to Luzon	$12,000,000
Inter-island communication for the Hawaiian group	$150,000
To complete the Inter-island telegraph system of the Philippines	250,000
For Alaska telegraph system, as already authorized by Congress	450,000
To extend the Alaska telegraph system and to connect it to the United States by direct cables, and also for further extension to the Philippines via the Aleutian Islands, providing a duplicate trans-Pacific route to the Philippines	10,000,000
For cable connections with Tutuila Island coaling station at Pago Pago Harbor	650,000

CABLES IN THE ATLANTIC.

Direct cable from the coast of the United States to the island of Porto Rico	1,500,000
Total	$25,000,000
Estimated cost of proposed Isthmian Canal	$200,000,000
Relative cost of two enterprises	1 to 8

This estimate, which is necessarily a very general one, due to the great fluctuations in the price of materials, the inexperience of American manufacturers, etc., shows that with an expenditure of $25,000,000, or perhaps $30,000,000 at most, the United States can have a telegraph system connecting all her possessions, and placing each part of such possessions in direct connection with the United States by the best and most efficient means of communication known.

For the expense of three or four first-class battleships, the United States can provide herself with the most powerful means known for extending and preserving her commercial influence and for the speedy pacification and civilization of the people who have recently come under her control, and can secure a strategic advantage—military, naval, and political—which is necessary to her position as a world power.

Submarine cables are now established for colonial, political, and diplomatic reasons, as really as for their purely commercial purposes. Nor is actual state of war of the country itself the only fear; witness the present plight of France due

to the Transvaal War; owing to the fact that the cables to South Africa are under the control of England, and the establishment by her of a war censorship, France is absolutely dependent upon England not only for news from the Transvaal, but also for communication with her own colony of Madagascar, and her South Africa possessions. The importance of this subject has led her Colonial Commission to recommend recently the immediate construction of submarine cables, joining France with Senegal, Madagascar, and Tonkin, the latter connecting with the Danish company's cables. Indeed, the plan ultimately involves an estimated expenditure of $25,000,000 and includes a complete colonial cable system.

THE MILITARY CONTROL OF SUBMARINE CABLES IN TIME OF WAR.

The International Convention for the Protection of Submarine Cables, which met at Paris in 1884, made no provision defining the rights and immunities of cable property in time of war.

In addition to incorporating an article in the convention stipulating that this convention shall in no wise affect the liberty of belligerents, Lord Lyons, the British delegate, submitted the following declaration at the moment of signing the convention: "Her Majesty's Government understands Article XV in this sense, that in time of war, a belligerent, a signatory of the convention, shall be free to act in regard to submarine cables, as if the convention did not exist."

M. Leopold Orben, in the name of the Belgian Government, also submitted the following declaration:

"The Belgian Government, through its delegates to the conference, has maintained that the convention has no effect upon the rights of belligerent powers. Those rights would be neither more or less extensive after the signature than they are now. The mention inserted in Article XV, although absolutely useless in the opinion of the Belgian Government, would not, however, justify a refusal on its part to unite in a work the expediency of which is indisputable."

Before the Spanish-American War there were few examples of damages done to submarine cables by belligerents.

As has been pointed out, Article XV of the Convention of Paris, of 1884, for the Protection of Submarine Cables, subscribed to by twenty-six nations, specifically states that "The stipulations of this convention shall in no wise affect the liberty of belligerents." In consequence, the question as to what, if any, special protection was to be accorded submarine cables in time of war, remained theoretical until the Spanish-American War of 1898, when a practical rule of action was outlined by General A. W. Greely, Chief Signal Officer of the United States Army.

Upon the declaration of war, General Greely, upon whom by law devolved the operation of military telegraph lines and cables, was called into the national council for his opinion as to the line of action best calculated to subserve the legitimate rights of commerce and industry, while conserving the military interests of the United States. He took the view that, inasmuch as postal communications were forbidden between belligerents, prohibitive orders should be issued against such telegraphic correspondence as might benefit the public enemy, pointing out that telegrams, by their secrecy and rapidity, produce military results much more important and injurious than are possible by the use of the mail.

General Greely advised that cable operations should continue over the international cables between Havana and Florida, of course under strict military censorship, and his firm stand prevented any interruptions of this cable system. By his orders Captain R. E. Thompson, Signal Corps, United States Army, took military possession of the Key West telegraph office on April 23, 1898, and cut the cables so that Jacksonville could no longer work with Havana. Domestic and

business messages in open text were allowed to be sent and received from Havana, but only under strict military censorship. Similar action was taken at Havana by the Governor-General of Cuba, who established a rigid Spanish military censorship, so that all messages were subject to double scrutiny.

By his instructions General Greely recognized the existence of five classes of cables:

First: Those of which the termini are in the enemy's country; for instance, the Cuba Submarine Cable system along the south coast of Cuba.

Second: Cables which directly connect countries at war, so that each belligerent controls one end of cable; for instance, that of the International Oceanic Telegraph Company between Florida and Havana.

Third: Where one end of the cable is in the enemy's country and the other in neutral territory; for instance, the West India and Panama cables extending through Cuba to Porto Rico, and thence to Saint Thomas.

Fourth: Where a cable extends from the coast of an offensive belligerent to a neutral country contiguous to the territory of the defensive belligerent; for instance, the Haiti Cable from New York City to Haiti, where there is direct cable connection with the Island of Cuba.

Fifth: Cables having one terminus in the territory of the offensive belligerent and the other in neutral regions remote from the scene of hostility; for instance, the Atlantic cables connecting the United States with Europe.

To cables of the first class, whether the property of the defending enemy or a neutral corporation, was applied the simple and well-known rule that they are subject to the vicissitudes of war, and that being in use for war purposes they are proper objects of offensive military operations. The orders issued to the officers of the Signal Corps looked upon these cables, whether they were laid in the high sea or along the immediate coast, as liable to seizure and total destruction.

Cables of the second class were easily dealt with. The cables between Key West and Havana were taken possession of, militarily, by Spain in Cuba and by the American Army in Key West. Messages going and coming were subjected to the most rigid military censorship at both ends of the cable. Only messages in plain text bearing upon business and social subjects were permitted, and where any suspicion existed as to the loyalty of the sender were either refused or not sent. Exceptional cipher messages were permitted as a matter of courtesy and favor to selected diplomatic representatives of neutral nations.

The cables of the third class were viewed as contraband of war; but it was also recognized that their liability to destruction depended in a measure on the locality of the cable. General Greely recognized as unsettled and of doubtful expediency the right of any belligerent to raise from the bottom and destroy on the high sea a neutral cable, merely on the ground that such cable landed in a hostile country. He, however, applied a more rigid rule to such portions of cables, cable huts, instruments, etc., as were located within the territorial jurisdiction of the enemy. This rule was based on the principle that such cable property, whether belonging to an enemy or to neutral corporations, is not only subject to the vicissitudes of war, but, being contraband of war, is a legitimate object of military operations. In accordance with this view his orders to Colonel James Allen, Signal Corps, charged him to use his utmost efforts to cut off the south coast of Cuba any cable that could be grappled and picked up, either within a marine league of the coast, or within range of Spanish batteries.

In Cuba and Porto Rico, during the Spanish-American War, certain neutral cable stations of this class fell within the

power of the Army of the United States. In such cases the officials of the neutral cable companies were given a choice of action. They could abandon their property to the vicissitudes of war, or accepting the *force majeure,* were allowed to transact business under strict military censorship. Even during the siege of Santiago the orders permitted the French Telegraphic Cable Company to accept business for Santiago de Cuba within the Spanish lines, every such message, however, to be viséd by the military censor.

The fourth class of cables were seized by the military forces of the United States and operated under strict military censorship. Code and cipher messages were absolutely refused save for the authorized government agents and certain excepted diplomatic representatives, the latter as a matter of courtesy.

Cables of the fifth class were placed under a military censorship. Of these, there were six systems comprising separate cables. Most of these telegraph cables were only constructively seized, General Greely taking the responsibility of intrusting the direct censorship of messages, under the general supervision of an officer of the Signal Corps, to the respective superintendents, men of high character, whose good faith was guaranteed by the companies whose interests they likewise guarded. The interests of the United States were thus subserved while the privacy of the affairs of the companies was conserved. The responsible officials gave a written pledge to observe such rules as might be filed by the Chief Signal Officer with the companies. These rules prohibited all messages to and from Spain, and also certain other classes which were deemed prejudicial to the military interests of the United States. In cases of doubt, messages of the latter character were examined and viséd by the military censor.

The events of the Spanish-American War brought to attention the whole subject of the legal rights of cable property and the control of the same under varying and complex conditions in time of war. In the absence of definite international law upon the many points involved, the United States was forced to take the initiative and use this powerful military weapon for the benefit of the cause of the United States, while at the same time respecting and subserving the rights of neutrals with an equity and fairness which has always characterized the actions of this Government when possible.

In the West Indian cables, as well as in the cable connecting the Philippines with Asia, the cable question was always a paramount one, and the United States finds herself now confronted with legal questions, growing out of actions necessary in time of war. Since submarine cables have become such a dominant influence in time of war, and since the cases which may naturally arise are often complex and involved, it is clear that a further international cable conference is a necessity of the near future, by which a more definite international understanding of methods of procedure in time of war may be attained. This international conference could properly consider other international cable matters, which the great advance in submarine telegraphy has made important. Among these may be mentioned the construction and authorization of a uniform international cable code, for the economical and efficient communication between different parts of the world in any of the principal languages now authorized by the international telegraph rules.

THE CABLE EQUIPMENT OF A FLEET.

It seems clear from the history of the Spanish-American War that provisions must be made for laying, picking up, cutting, and operating submarine cables in time of war. From the outbreak of this war every attention was given to the problem of isolating the island of Cuba from Spain.

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The special fitting out of the *Adria* with cable appliances, as well as spare cable, the work of the *St. Louis* in cutting cables, the operations of the *Marblehead, Nashville,* and *Windom* at Cienfuegos, and of the *Mangrove,* are too well known to be repeated here. It will be more valuable to endeavor to draw the correct conclusion from these operations, and thereby make proper provision for the execution of similar operations in time of war.

It appears that the searching for deep-sea cables in the high seas in time of war, without an accurate chart of the location of the cable, is a difficult and very doubtful operation; also that submarine cables must in general be interrupted near their landing places, where their exact location can be determined with certainty. From the experience of the Spanish-American War, operations of this kind are extremely dangerous, as the cable landing will be protected and defended by the enemy.

Supply of spare cable and suitable instruments for working the same must be available with every naval fleet—in order to supply the necessary communications with the shore, in case of the landing of either a coöperating army, or of temporary forces from the ships. Cable-ships engaged in either laying, cutting, or repairing cable near the shore, must either be provided with their own means of defence, or else convoyed by war-ships.

These facts make it clear that a new type of naval ship is to make its appearance as a necessary adjunct to every naval fleet. Just as the naval repair-ship, such as the *Vulcan,* has been found useful and necessary, so will the new cable cruiser be an essential part of the navy of the near future. It is not intended here to enter into the question of the proper design of such ships, but it would seem that a specially designed cable-ship, with comparatively large coal capacity and high speed, and an armament of the lighter cruiser class, making her capable of defending herself and protecting her small-boat parties, would be best adapted for the purpose. She must carry a moderate supply of spare cable and machinery for laying and picking up cable, as well as instruments for testing and operating a cable, and the necessary buoys, suitable, if necessary, for buoying the cable, and operating the ship as a floating cable station. It is unnecessary to state, also, that her personnel must be specially trained in the highly technical duties required, and from actual practice in all the operations necessary, be made ready for the performance of their duties efficiently under the conditions of war.

Although these naval cable cruisers in time of peace could be profitably employed in maintaining and repairing both cables belonging exclusively to the government, and those subsidized by the government, under suitable arrangements, yet, at the outbreak of war they should be absolutely and exclusively under the control of the government. It may be said at present that no modern fleet is complete without a cable-ship, especially adapted for cable operations in time of war.

Since submarine cables are so important a factor in national defence, they should be protected both at their shore landings and on the high seas by military and naval force.

In this connection it would seem advisable in case of government cables, or of cables subsidized by the government, to keep the exact route of important cables a secret, and prevent the publication of maps for general distribution, showing their exact location in the deep sea. The location of the shore ends, however, is certain to be known.

A cable landing, for the future, should partake of the character of a fort, and be provided with adequate means for preventing an enemy from locating and destroying the cable within the marine league, or, until it has reached deep sea, where its accurate location is not known.

The sea is usually considered as the great international highway, belonging equally to all nations; this, however, is no longer true. The real political boundaries of states are no longer defined and restricted by the land, but involve such portions of the high seas as a nation can, by her commercial and naval vessels, and her submarine cables, reach out and secure. In this great sea division, which is so surely taking place, probably there are no better guides to boundaries than the submarine cable net-works which lie in its great depths. Since each in general uses the shortest path between two points, the general commercial sailing lines are also the general direction of cable lines.

The United States will be wise if, in the great Pacific where she has such paramount natural advantages, both for commerce and for maritime strength, she pursues a broad, vigorous, and even lavish "cable policy." We should be able at the earliest date to manufacture upon American soil deep-sea cables of the first class; be able to lay, maintain, and repair them in time of peace or war by ships flying the American flag, and be prepared to adequately protect them upon the high seas, and at their landing places by military and naval force.

The cable question is one of the most important of the present hour, unique in that American commerce, diplomacy, and sea-power—in fact the most efficient means of advancing and securing the benefits of civilization itself—happily conspire in demanding its early solution.

THE INDIAN TRIBES OF SOUTHERN PATAGONIA, TIERRA DEL FUEGO, AND THE ADJOINING ISLANDS

By J. B. HATCHER

Carnegie Museum, Pittsburg

IT is the purpose of this paper to record some observations made by the writer among the Indian tribes of Southern South America, during the three years of exploration conducted by him in that region in behalf of Princeton University. The country occupied by the people under discussion embraces that part of South America lying beyond the forty-sixth parallel of south latitude, including the mainland and the adjoining islands as far south as Cape Horn. The people living in this region belong to four distinct tribes, each inhabiting a certain limited area and differing from the others in language, customs, physical development, and especially in the activities necessary to, and the mechanical appliances employed in, the gaining of a livelihood.

Owing to the natural barriers to social or commercial intercourse, presented by the topography of the region, communication between the different tribes is now and always has been extremely limited. This long period of comparative isolation has, with one exception, permitted each tribe to remain practically uninfluenced by the others, and has doubtless contributed to produce those linguistic and sociologic features at present so distinctive of each.

Commencing with the mainland we shall first consider the Tehuelches, that so-called race of giants, made famous

by the exaggerated accounts of them brought home by the earliest travellers from Magellan's time to the beginning of the present century. Of splendid physique, they are abundantly able to withstand the rigorous climate of the bleak, treeless plains of Eastern Patagonia, where they live and find ample sustenance and wholesome employment in the pursuit and capture of the guanaco and rhea; both of which are extremely abundant throughout the entire extent of this region.

As a people, though not the race of giants they were commonly reported to be by most early writers, the Tehuelches are, nevertheless, decidedly above the average size. Of the three hundred Tehuelches living between the Santa Cruz River and the Strait of Magellan, I should place the average height of the men at not less than five feet eleven inches, with an average weight of one hundred and seventy-five pounds. While the fully grown women (those above twenty-four years of age) I should estimate at five feet seven inches, and of an average weight of but little, if any, short of that of the men. This lack of disparity between the physical development of the sexes is paralleled also in their mental development. It is noteworthy, and is due very largely to the division of labor among them. The labor necessary for the support of the family is more equally divided between husband and wife, among the Tehuelches, than is common with the Indian tribes of North America.

That these Indians are muscular and well proportioned, is seen by a glance at the illustrations accompanying this paper. There is a tendency to obesity rather than angularity. Conscious of their physical strength, like most persons of great physique even among the more civilized nations, they exhibit a kindly manner and gentle disposition. Accustomed to the free life of the plains, and living in the midst of an abundance of those animals that for centuries have supplied all their simple wants, they display that homely hospitality so characteristic of well-fed and well-clothed savage and semi-civilized people in sparsely settled countries. The frank, open countenance of the Tehuelche at once allays any uneasiness and establishes a feeling of confidence in the mind of the solitary traveller who, in the course of his lonely wanderings throughout Patagonia may, by chance or necessity, be thrown among them.

The Tehuelches were formerly a considerably more numerous people than at present, though it is hardly possible that they at any time numbered more than 5,000. It is doubtful if there are more than five hundred of them remaining in all Patagonia, and this small number is being rapidly reduced by diseases introduced among them through contact with the whites. That they are not a prolific people is strikingly evidenced by the small number of children common to pure-bred Tehuelche families. In cases where both parents were of pure Tehuelche stock, I do not remember to have seen more than three children in any one family, while one or two were much more generally the number, and frequently there were families with no children. On the other hand in those families where a Tehuelche woman was married to a husband of Spanish, French, or Portuguese descent, such unions were, as a rule, ordinarily productive of offspring, there being frequently six or seven children to the family.

Firearms are quite unknown among the southern Tehuelches. They rely entirely upon their skill with the bolas, aided by their horses and dogs, for the capture of the guanaco and rhea, from which they derive not only their chief sustenance, but also the skins employed in the construction of their clothing, bedding, and tents or toldos. Formerly they used the bow and arrow, but with the introduction of the horse at the advent of the Spaniard, the bola entirely supplanted the bow and

arrow, and at present the latter weapon is no longer seen among them.

The changes wrought upon the Tehuelches by the advent of the horse, is a subject well worthy of the attention of the anthropologist. To this professional capacity I lay no claim, but I wish to mention some observations made by myself bearing directly upon this subject. Not only was the advent of the horse the determining factor in supplanting the bow and arrow by the bola among these Indians, but the introduction of that useful animal produced other most decided changes in the life and habits of the Tehuelches. Prior to the introduction of the horse they were dependent upon the bow and arrow not only for securing their food and clothing, but also for protecting themselves from the more numerous and warlike Indians who inhabited the country to the north, and with whom they were constantly at war. Greatly outnumbered by a deadly enemy and deprived of any rapid means of escape if attacked by a superior force, their favorite camping places were then chosen with reference to concealment and defence, quite as much as, or even more than, for their convenience to natural food supplies. In those pre-equine days, if I may use the term, the Tehuelche was wont to select for his encampment a secluded place in the bottom of some deep basalt cañon, adjacent to a stream or small spring, or if living on one of the larger rivers, the encampment would be situated not in a conspicuous place in the bottom of the valley, convenient to an abundance of grass and water, as at present, but would be hidden away in some bend of the stream or placed high up among the débris of basaltic rocks that encumber the slopes of most of the more important streams of the Patagonian plains. In such positions their low, box-like toldos, made of guanaco skins of a dull brown color, would not be easily detected.

Many such old camping places may now be seen, strewn with pieces of broken pottery, worn out and discarded stone scrapers, stone chippings, arrow points, drills, mortars, etc. A site of one of these old-time Indian villages I examined very carefully. The bottom of the cañon bears unmistakable evidence of having been long used as a favorite camping ground of the Tehuelches. The soil over a considerable area is literally filled and covered with stone chippings, scrapers, broken pottery, broken and charred fragments of bones of mammals, birds and fishes, the latter taken from the stream which still flows between the village site and the high bluff beyond.

At this place I picked up about two hundred arrow points and drills, most of them imperfect, but did not find a single bola. Is it not possible that the introduction of the horse brought about the abolition of the bow and arrow and the adoption of the bola as a weapon of offence and defence? The bola, considering the limit of its effective range, and the time necessarily consumed in attaining a sufficient impetus before discharging it, certainly does not appear to be especially well adapted for the capture, by a man on foot, of animals possessed of such speed and endurance as are the guanaca and rhea. Whether the bola was in use among these Indians prior to the advent of the horse, can perhaps never be definitely determined, but there can be little doubt that as an implement for the capture of game, it came into far more general use after the introduction of the horse, when it began gradually to displace the bow and arrow, finally resulting in the total disappearance of the latter weapon. Throughout my travels in Patagonia I was struck by the almost total absence of bola stones about the old village sites, where arrow points were as a rule found in unusual abundance. The place just referred to was evidently long occupied as a favorite encampment. That it has been long abandoned is evident from the fact that over considerable areas implement-bearing strata are buried beneath several feet

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of æolian drift materials. Moreover, the locality is one absolutely unfitted as a camping place for the present Indians, accompanied as each band invariably is by several hundred horses, thus necessitating the selection of a site near abundant grazing lands.

The coming of the Spaniard among the Tehuelches has resulted in the disappearance of still other implements than the bow and arrow. Scattered about the old village sites are numerous pieces of broken pottery, though the manufacture of pottery is now a lost art with the

Channel Indians of the West Coast and Western Part of Strait of Magellan.

Tehuelches. Upon examination of many of the more perfect of these earthen vessels, it was found that they were punctured with a series of small holes in the bottom, and that the surface of the interior, over the bottom and a considerable portion of the sides also, was blackened and charred, thus bearing unmistakable evidence of having been subjected to the continued action of fire. It occurred to me that such earthen vessels were used for conveying fire from one encampment to another when on the march. Upon inquiry I was pleased to hear this theory confirmed by an aged Tehuelche woman who remembered distinctly that in her childhood fire was frequently transported with them when on the march.

The Tehuelches find their chief employment in hunting the guanaco and rhea or South American ostrich. The region inhabited by them extends northward from the Strait of Magellan along the western border of that part of the country occupied by the prosperous Patagonian sheep farmers, and which lies adjacent to the Atlantic coast. This sheep-farming district extends westward from the coast for an average distance of about thirty miles. Between this thirty-mile strip and the Andes is the home of the Tehuelche. Of the habitable portions of the earth's surface, it is perhaps the most sparsely settled of all. Notwithstanding its natural resources, over thousands of square miles are entirely uninhabited. For the most part, it is indeed comparatively barren, as in the lava beds of the central interior region, but to the westward over the lower slopes of the Andes and in the valleys entering the mountains, there are exceedingly fertile regions, capable of supporting considerable populations, but at present quite unoccupied by either Indians or Europeans. The writer, together with Mr. O. A. Peterson, spent five months of travel during the summer of 1896–97 in the country lying between the sources of the Santa Cruz and Desire Rivers without encountering either whites or natives.

The Tehuelche is and always has been a plainsman. His methods and the implements employed by him in the chase are designed for a level open country, and are not adapted to rough, mountainous, or wooded districts. Greatly reduced in numbers he finds the area still left to him in his natural habitat more than ample to supply his simple wants and satisfy his inherent, nomadic disposition. Left to himself, his necessities are few and easily supplied, for nature in Patagonia is exceedingly lavish in furnishing those animals that provide him with every domestic necessity. Give to the Tehuelche his horse, dogs, and bolas, and destroy all other animal life indigenous to the region save only the guanaco, and he would continue to exist, experiencing little inconvenience.

The guanaco is to his existence the one important and indispensable animal. From its flesh he derives his chief and for long periods only sustenance, while from its skin his industrious wife constructs the family toldo and makes with admirable skill and patience their ample clothing and bedding, fitting and sewing the parts with the nicety and proficiency of a skilled seamstress. A wooden or bone awl used as a delicate punch is her needle, and the sinew taken from the loin of the same animal her thread. From this same beast he likewise obtains the sinew for the light but exceedingly strong thongs of his bolas.

But the guanacos are in no danger of extinction. They roam in thousands over the Patagonian plains. So abundant are they that in travelling across the country it is scarcely possible to pass out of sight of them. Contrary to the general rule with undomesticated animals, the guanacos inhabiting settled regions are far less timid than those of unsettled districts. In that region along the coast occupied by the sheep farmers, they exist in great numbers, are exceedingly tame, and are a source of considerable annoyance to the herdsmen, who nevertheless suffer them to go unmolested.

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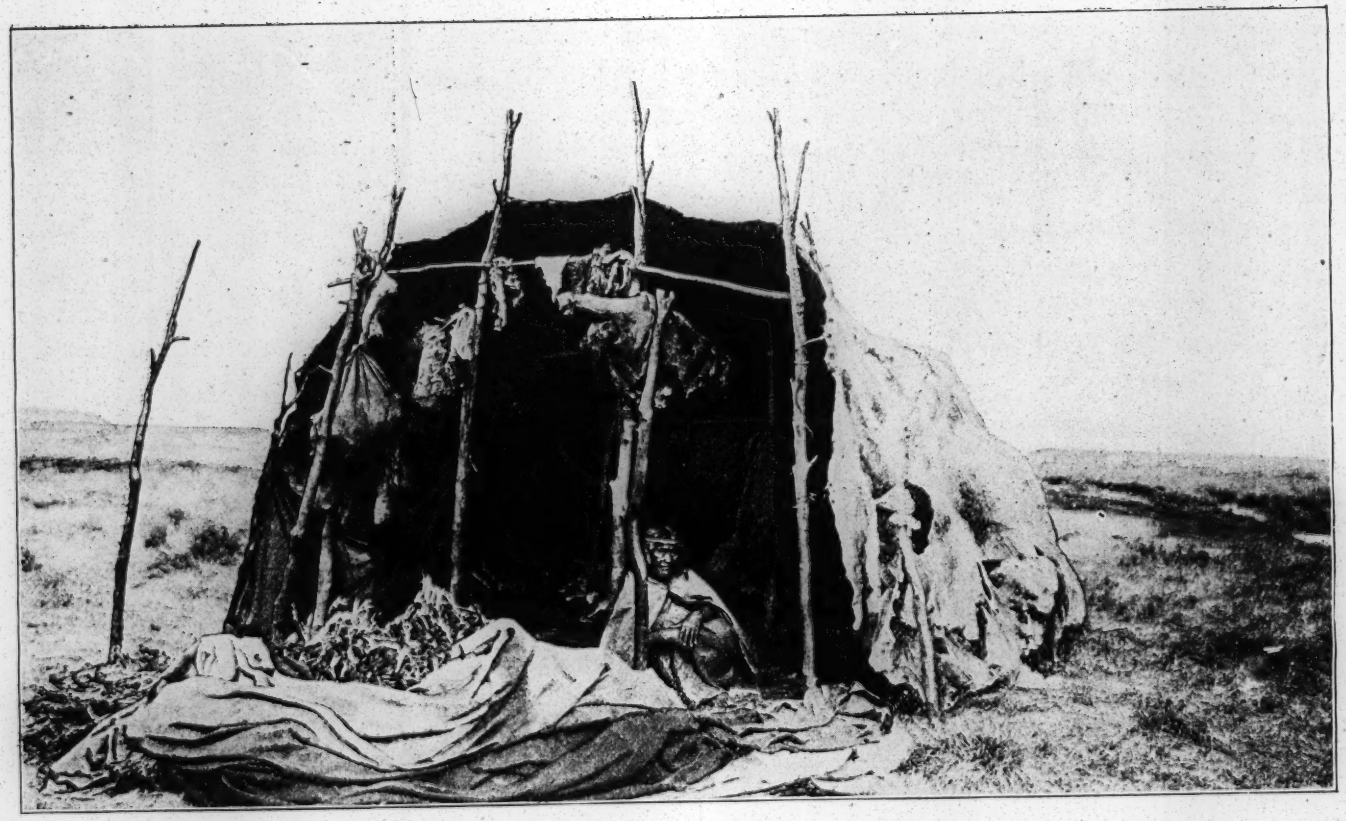


Tehuelche Tent.

Beyond the settlements the guanacos are more difficult of approach, and in the Cordillera they are exceedingly wary, as is also the rhea or so-called ostrich. This is the more striking and difficult of explanation since the deer in the same mountainous region seem absolutely fearless and prompted by curiosity rather than fear when approached. On several occasions, when in need of meat while travelling through the Southern Andes, we located a band of deer and walked directly up to within twenty or thirty feet of them before shooting. Neither the report of the rifle nor the death-struggles of their companion aroused in them any apparent feeling of uneasiness. The surviving members of the band stood about at a distance of only a few feet, taking notes as it were, while we were engaged in skinning and dressing the carcass of their fallen comrade, often approaching so near that we would be compelled to suspend operations and urge the spectators to remove to a more respectful distance.

THE ONAS OF THE FUEGIAN PLAINS.

Closely resembling the Tehuelches and evidently derived from the same original stock, are the Onas, inhabiting the plains and timbered regions of central, northern, and eastern Tierra del Fuego. Like the Tehuelches they are of splendid physique and live entirely by the chase. They are essentially a plains people and only occasionally frequent the coast. Their island having been separated from the mainland for a remote period of time, they have been practically cut off from all communication with their relatives on the northern shores of the eastern stretches of the Strait, and have thus developed a language quite distinct from that of the Tehuelches, while many of their customs and arts differ materially from those of the latter. Not being a maritime people, they have been unable to import the horse from the mainland, so that the Onas of today are in much the same condition as were the Tehuelches of the mainland prior to the introduction of the horse. With the Onas the bow and arrow is still the one indispensable weapon for offence and defence, while bolas and horses are quite unknown among them.

Owing to the extremely advantageous nature of their lands for sheep-farming purposes and the consequent aggressiveness of the Fuegian sheep-grower of the present day, the tribe is being rapidly decimated, and their extinction in the no distant future seems inevitable. Already their natural habitat is entirely occupied by Europeans, and they have been driven back into less favorable districts where food is scarce and obtained with difficulty. Naturally a state of constant warfare exists which will inevitably lead to the extermination of the Onas.

THE CHANNEL INDIANS.

Between the eastern and western coasts of Patagonia and Tierra del Fuego there are extreme climatic and physiographic differences. The treeless, semi-arid, and level plains of the east coast, with but few indentations, are replaced on the west by an intricate series of islands, peninsulas, capes, and promontories, separated by a labyrinth of inlets, bays, sounds, and channels, surrounded by one of the most picturesque and rugged mountain systems to be seen anywhere on the earth's surface. These mountains serve as a barrier to the southwesterly winds that prevail here, and effectually deprive them, during the passage over their summits, of most of the moisture with which they have become charged on their long journey across the Southern Pacific. Thus precipitation is constantly taking place, and the surface is perpetually drenched with moisture, thereby producing a vegetable growth, which at low altitudes, even in the latitude of the south and west coasts of Tierra del Fuego, rivals in profusion and luxuriance that of the Tropics. It contrasts strikingly with the eastern plains and river valleys, which are destitute of trees or forests

A Tehuelche Brave—Twenty-five Years of Age.

and where the annual precipitation is just sufficient to support a few species of short but succulent grasses, with occasional clumps of low, scrubby, and usually thorny bushes, characteristic features of semi-arid regions.

The natives of the Pacific coast differ from those of the Atlantic quite as much as do the climate, vegetation, and physiographic features. The natives of the west coast, while belonging to at least two distinct tribes, may be very appropriately denominated, collectively, as Channel Indians. All their activities cluster about the coast. They live on and about the shores of the inland waters of the Fuegian Archipelago and the west coast of Patagonia, never venturing inland for more than a few miles. They are essentially a maritime people, deriving their chief and almost only sustenance from the sea. They are small in stature and inferior in physique to the Tehuelches and Onas of the Patagonian and Fuegian plains, and their origin has undoubtedly been quite distinct from that of the latter tribes.

For houses they usually erect exceedingly primitive structures formed of interwoven or piled-up branches of trees, which would seem, even to most semi-civilized peoples, quite inefficient protection from the storms that almost constantly prevail here. They find their chief occupation in collecting shell-fish, in fishing, and in hunting the fur-seal and sea-otters. From the skins they make their scanty clothing, while the flesh and blubber serve them as additional food.

The chief food of the Channel Indians is the shell-fish that live in great abundance in the waters of this coast. When the supply of shell-fish of any particular cove which may have been selected as a camping-place by a party of these Indians becomes reduced, they place their few domestic necessaries in their canoes and proceed by water to a new encampment where food is abundant. In this manner they move about from place to place in order to procure sufficient food. They eat their food either raw or slightly roasted on fires that are kept constantly burning on a few sods placed in the bottoms of their canoes. They are not entirely carnivorous, frequently varying their diet by the addition of a few species of edible fungi that grow on the beech-trees of the adjacent forests.

Their canoes are fashioned of large slabs of bark supported by numerous ribs of wood and sewed together with thin strips of whalebone. Sometimes they use, instead of bark, thin slabs of wood hewn out with great patience. One or two instances of true dugouts have been reported among the Yahgans inhabiting the eastern portion of the south coast of Tierra del Fuego and the islands about Cape Horn. Their harpoons and spears are almost always of bone.

The Channel Indians are of two distinct tribes, differing in language, though for the most part quite similar in their mode of life and in the arts employed by them in the gaining of a livelihood. The more numerous and more warlike and powerful of these tribes are known as the Alaculoffs. They occupy all the west coast of the mainland together with the adjacent islands, the western stretches of the Strait of Magellan, southern and western Tierra del Fuego as far east as Beagle Channel, and the islands lying to the southwest. The remaining south coast of Tierra del Fuego and the adjoining islands as far south as Cape Horn are the home of the Yahgans, formerly the most powerful of all the Indian tribes of this region, but now nearly exterminated by the combined attacks of the Onas and Alaculoffs, aided by diseases, chiefly pulmonary, introduced among them through the mistaken kindnesses of over-zealous missionaries, themselves exceedingly deficient in the first principles of hygiene.

The Yahgans are doubtless only a remnant of a once powerful people that inhabited the region now occupied by the Alaculoffs. They have been crowded into

Tehuelche Squaw.

narrower and narrower limits until finally reduced to their present territory. That they have long dwelt in their present habitat is evidenced by the numerous shell-heaps that have been accumulated about the more favorable camping places along the bays and inlets of this coast. These shell-heaps or kitchen-middens have been observed attaining to a height of twelve or fifteen feet and to more than one hundred feet in length. The time consumed in the accumulation of such quantities of shells indicates for them a considerable antiquity.

LOCATION OF THE BOUNDARY BETWEEN NICARAGUA AND COSTA RICA

BY ARTHUR P. DAVIS, CHIEF HYDROGRAPHER, ISTHMIAN CANAL COMMISSION

THE promise which the construction of a water-way gives of increased development and commercial importance to the Central American republics, has been a source of considerable jealousy between Nicaragua and Costa Rica, and until recently there was continual dispute over the boundary line between these republics, each being anxious to preserve and increase its territorial interests in proximity to the proposed canal route. Both states had been wrought up by years of fruitless negotiations to a state of readiness for war in defence of what they considered their rights. In fact, war had actually been declared by Nicaragua on November 25, 1857, when, through the mediation of the Republic of Salvador, a final effort to avert it was made. Another convention was held and a definite treaty was concluded between the two republics in April, 1858, Article 2 of which runs as follows:

"The dividing line of the two republics, starting from the northern sea, shall commence from the extremity of Castilla Point, at the mouth of the Rio San Juan of Nicaragua, and shall continue its course along the right margin of said river to a point 3 English miles distant from the Castillo Viejo, measured from the exterior fortifications of said castle to the point indicated. From there a curve will start, the centre of which shall be said works, and shall preserve a distance of 3 English miles from it throughout its development, terminating at a point which shall be 2 miles distant from the bank of the river, upstream from the castle. From there the line shall continue in the direction of the Sapoa River, which empties into Lake Nicaragua, following a course almost 2 miles distant from the right margin of the Rio San Juan, with its circumvolutions, to its origin at the lake, and of the right margin of the lake itself to the said Sapoa River, where this line, parallel to said margins, will terminate. From the point of intersection with the Sapoa River, which, from what has been said, should be 2 miles distant from the lake, a right astronomical line shall be drawn to the central point of Salinas Bay, in the southern sea, where the demarcation of the territory of the two republics shall terminate."

This boundary was for many years unsurveyed, and after the treaty of 1858 a change occurred in the regimen of the San Juan, by which the main portion of its waters, instead of flowing to the sea

at San Juan del Norte, as formerly, followed another course to the ocean, known as the Colorado River, while the lower San Juan, which was formerly the main stream, became a subordinate distributary. This led to a new dispute, Nicaragua claiming that the main stream, or Colorado River, was the true boundary, and calling in question in general the validity of the provisions of the treaty of 1858. This dispute was submitted to the arbitration of President Cleveland, who made an award on March 22, 1888, declaring the treaty to be valid, and the old or San Juan River to be the line. This decision was accepted by both republics, and at their request an umpire was appointed by President Cleveland to decide doubtful points during the survey of the boundary line. General E. P. Alexander, of North Carolina, was appointed to fill this position, and the boundary line has recently been surveyed.

During the progress of this survey several interesting points of difference arose between the representatives of Nicaragua and Costa Rica, which were decided by the arbitrator to the satisfaction of both parties. The first point, and a very important one, related to the point of beginning, called in the treaty "Punta de Castilla." The lower San Juan, after separating from the Colorado, flows toward Greytown for a considerable distance and then sends a small distributary to the ocean called the Tauro. The main river reaches the Caribbean near Greytown, through two mouths with an insular delta between them.

Nicaragua claimed that the mouth of the Tauro should be considered as the mouth of the San Juan, and that the point of beginning was at the right bank of the mouth of this distributary, but there seems to have been little basis for this claim.

Costa Rica claimed as the starting point the western extremity of the deltaic island, the base of this claim being that this was the right bank of the mouth of the main San Juan and that it had been called Punta de Castilla by three authorities cited, one of them being a prominent Nicaraguan politician, Mr. J. A. Gamez.

The arbitrator pointed out, however, that a large array of authority, including nearly all public maps, called this Punta Arenas, and that if such an important concession had been made by Nicaragua the representatives of Costa Rica would certainly have insisted upon mentioning the name "Punta Arenas" in the treaty, and similarly, if the Tauro had been intended, the representative of Nicaragua would certainly have insisted upon the insertion of that name; but neither of these names occur in the treaty. The point which was the extremity of the headland of Punta de Castilla in 1858 has now long been swept over by the Caribbean Sea, and so many changes have occurred in the shore outline that it is not now possible to locate the exact spot. The arbitrator therefore decided that "under these circumstances it best fulfils the demands of the treaty and of President Cleveland's award to adopt what is properly the Headland of to-day; or the northwestern extremity of what seems to be the solid land on the east side of Harbour Head Lagoon; and the initial line of the boundary to run as follows, to-wit:

"Its direction shall be due northeast and southwest, across the bank of sand, from the Caribbean Sea into the waters of Harbour Head Lagoon.

"It shall pass, at its nearest point, three hundred (300) feet on the northwest side from the small hut now standing in that vicinity.

"On reaching the waters of Harbour Head Lagoon the Boundary Line shall turn to the left, or south-eastward, and shall follow the water's edge around the Harbour, until it reaches the river proper by the first channel met.

"Up this channel, and up the river proper, the line shall continue to ascend as directed in the Treaty."

The next point of difference was that

with regard to the edge of the river, Nicaragua claiming that it should be the edge at high water and Costa Rica claiming the edge at low water. Both claims were overruled, that of Nicaragua including as a portion of the river large areas of land covered with vegetation submerged at extreme high water, and Costa Rica's including within her territory numerous islands which were connected to the land by sand-bars, exposed at extreme low water. As the river was referred to in the treaty always as a navigable stream, General Alexander decided the line to be that indicated by the surface of the water at the lowest navigable stage of the river, which is rather above the average height, the lower river being scarcely navigable at mean stages.

The survey followed this line on the right bank of the river to a point three English miles below the Castillo Viejo. Here the line left the river, the point being marked by a large concrete monument. From here, owing to the dense tropical jungle, the line was not actually run, but points upon the line were located on streams, and at other places which were accessible either by boat or by land, and every foot of the line from Castillo to the Pacific is located by a compromise of the engineers.

Another important point of difference was with regard to the definition of the expression "the right margin of Lake Nicaragua." The argument and award of General Alexander are as follows:

"Under the influence of rainy seasons of about seven months, and dry seasons of about five, the level of Lake Nicaragua is in constant fluctuation. We shall have to discuss five different stages.

"1st. Extreme high water; the level reached only in years of maximum rainfall, or some extraordinary conditions.

"2nd. Mean high water; the average high level of average years.

"3rd. Mean low water; the average low level of average years.

"4th. Extreme low water; the lowest level reached in years of minimum rainfall, or other extraordinary conditions.

"5th. Mean water; the average between mean high water and mean low water.

"The argument presented to me in behalf of Nicaragua claims that the level to be adopted in this case should be the first level named, to-wit: extreme high water. It argues that this line and this line alone is the true limit of what the argument calls the 'bed of the lake.' Costa Rica claims the adoption of the third level, to-wit: mean low water. This is argued principally upon two grounds: First, it is shown by a great number of legal decisions that, in most states, all water boundaries are invariably held to run at either extreme or mean low water. Second, it is claimed that, in case of any doubt, Costa Rica is entitled to its benefits, as she is conceding territory geographically hers.

"I will begin with Costa Rica's first argument. The equity of adopting a low water line in the case of all water boundaries is readily admitted, even though instances of contrary practice exist.

"Between all permanent lands and permanent waters usually runs a strip of land, sometimes dry and sometimes submerged. We may call it, for short, semi-submerged. Its value for ordinary purposes is much diminished by its liability to overflow, but, as an adjunct to the permanent land, it possesses, often, very great value. If the owner of the permanent land can fence across the semi-submerged he may save fencing his entire water front. He also can utilize whatever agricultural value may be in the semi-submerged land in dry seasons. Both of these values would be destroyed and wasted if the ownerships were conferred upon the owner of the water. Therefore equity always, and law generally, confers it upon the owner of the permanent land.

"I recognized and followed this principle in my award, No. 3, where I held that the boundary line following the right

bank of the San Juan River, below Castillo, follows the lowest water mark of a navigable stage of river. And, if now the lake shore were itself to be the boundary of Costa Rica, I would not hesitate to declare that the semi-submerged land went with the permanent land and carried her limits at least to the mean low-water line.

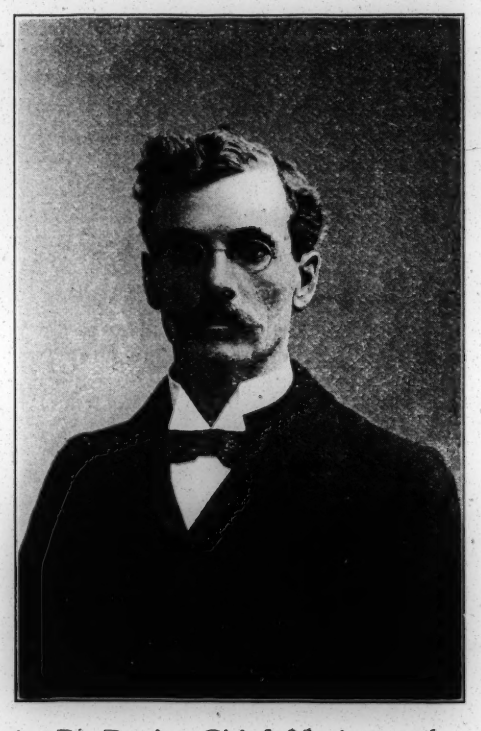
"But this case is not one of a water boundary; nor is it at all similar, or 'on all fours' with one, for none of the equities above set forth have any application. It is a case of rare and singular occurrence and without precedent, within my knowledge. A water line is in question, but not as a boundary. It is only to furnish starting points whence to measure off a certain strip of territory. Clearly the case stands alone, and must be governed strictly by the instrument under which it has arisen. That is the treaty of 1858; and its language is as follows:

"'Thence the line shall continue towards the river Sapoa, which discharges into the Lake of Nicaragua, following a course which is distant always two miles from the right bank of the river San Juan, with its sinuosities, up to its origin at the lake, and from the right bank of the lake itself, up to the said river Sapoa, where this line parallel to the said banks will terminate.'

"The principles upon which the language and intent of treaties are to be interpreted are well set forth in the Costa Rica argument by many quotations from eminent authors. All concur that words are to be taken as far as possible in their first and simplest meanings—'in their natural and obvious sense, according to the general use of the same words'—'in the natural and reasonable sense of the terms'—'in the usual sense, and, not in any extraordinary or unused occupation.'

"We must suppose that the language of the treaty above quoted suggested to its framers some very definite picture of the lake with its banks, and of the two-mile strip of territory. It, evidently, seemed to them all so simple and obvious that no further words were necessary. Let us first call up pictures of the lake, at different levels, and see which seems the most natural, obvious and reasonable.

"The very effort to call up a picture of the lake, at either extreme high water or extreme low water, seems to me immediately to rule both of these levels out of



A. P. Davis, Chief Hydrographer, Isthmian Canal Commission.

further consideration. Both seem unnatural conditions, and I must believe that, had either been intended, additional details would have been given.

"Next; is the mean low water mark the first, most obvious and natural picture called up by the expression, 'the bank of the lake?' It seems to me decidedly not. During about eleven months of the year this line is submerged, invisible and inaccessible. It seems rather a technical

line than a natural one. The idea of a bank is of water limited by dry land with some elements of permanency about it. Even during the brief period when the line is uncovered, the idea of it is suggestive far more of mud and aquatic growths than of dry land and forest growths.

"To my mind, the natural, simple and obvious idea of the bank of a lake, in this climate, is presented only by the line of mean high water. Here we would first find permanent dry ground every day of an average year. Here an observer, during every annual round of ordinary seasons, would see the water advance to his very feet and then recede, as if some power had drawn the line and said to the waters, 'hitherto shalt thou come but no further.' Here the struggle between forest growths and aquatic vegetation begins to change the landscape. Here lines of drift, the flotsam and jetsam of the waves naturally suggest the limits of the 'bed of the lake.' . . . . .

"Without doubt, then, I conclude that mean-high-water mark determines the shore of the lake; and it now remains to designate that level, and how it shall be found.

"Several surveys of the proposed Nicaraguan Canal route, beside that of Commander Lull above quoted, have been made within the last fifty years. Each found a certain mean high level of the lake, and it might seem a simple solution to take an average of them all. But, as each adopted its own bench-mark on the ocean, and ran its own line of levels to the lake, I have no means of bringing their figures to a common standard. It seems best, therefore, to adopt the figures of that one which is at once the latest and most thorough, which has enjoyed the benefit of all of the investigations of all of its predecessors, and whose bench-marks on the lake are known and can be referred to. That is the survey, still in progress, under the direction of the United States Canal Commission. Its results have not yet been made public, but, by the courtesy of Rear-Admiral J. G. Walker, President of the Commission, I am informed of them in a letter dated July 10, 1899, from which I quote:

"'In reply I am cabling you to-day, as follows: 'Alexander, Greytown, Six;' the six meaning, as per your letter, 106.0 as mean high level of lake. This elevation of 106.0 is, to the best of our knowledge (Mr. Davis, our hydrographer), the mean high water for a number of years. . . .

"'The highest level of the lake in 1898 was 106.7, last of November. The elevation of our bench mark on inshore end of boiler at San Carlos is 109.37. . . .'

"'A complete copy of this letter will be handed you, and also blue-prints of the maps made by the Commission of the lower end of the lake, which may facilitate your work.'

"As this Commission is the highest existing authority, I adopt its finding, and announce my award as follows:

"The shore line of Lake Nicaragua, at the level of 106.0 feet, by the bench marks of the United States Nicaragua Canal Commission, shall be taken as the bank of said lake referred to in the treaty of 1858."

The location of the line around the southern margin of the lake was the most difficult part of the whole survey. The country here is a vast morass, densely covered with tropical vegetation, even the sluggish streams being mostly choked with aquatic plants. The high water line was defined as 106 feet, while the level of the lake at the time of the survey was about 102. It became necessary, therefore, to determine an elevation four feet higher, which was usually several miles from the water's edge.

By means of levelling, it was ascertained that the swamps had a mean slope toward the lakes of about one foot per mile, and this was made the basis of most of the agreements. A few points on streams were located, the area of Nicaragua's two-mile zone was calculated, and

the boundary was defined by long tangents, including the proper area.

On reaching the Sapoa River a monument was erected, and a broken line to Salinas Bay was run, the boundary of the bay itself was surveyed, and the island was located.

The last important point decided by General Alexander was perhaps the knottiest of all. It was the definition of the centre of Salinas Bay, and the decision was both just and ingenious. The remarks of the Arbiter are as follows:

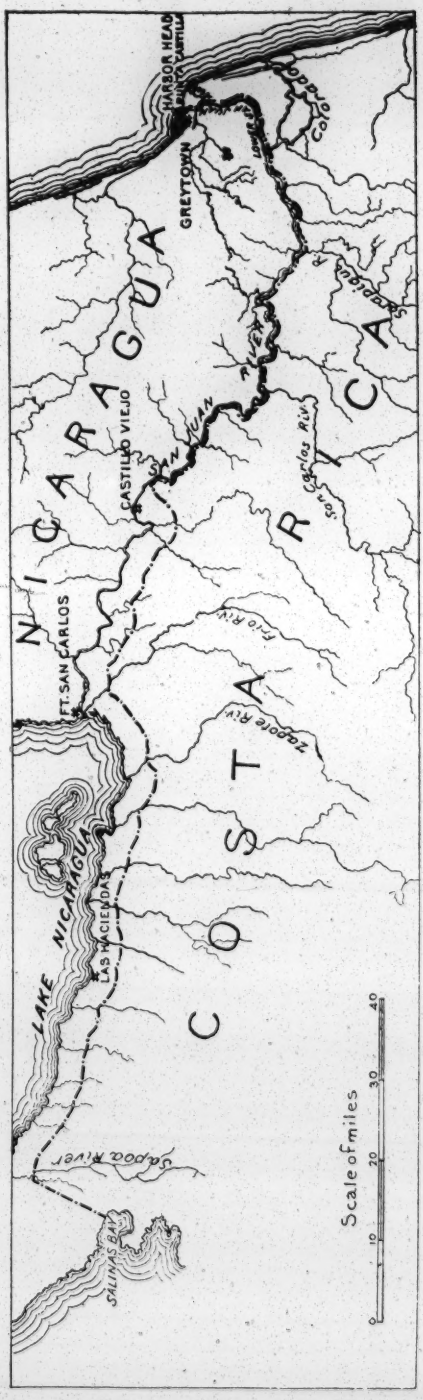
"The Bay of Salinas was carefully surveyed and mapped by officers of the United States Navy in 1885, and a map of the same is published in the United States Naval Hydrographic office, No. 1025. I have adopted this map, with the consent of both commissions, as correctly representing the outline of the Bay. In shape it is a curved pocket, starting east and bending southward, about five miles long, and about one-half of that in average width. Its outline a little resembles the rounded handle or butt of a pistol, with some irregular projections and indentations.

"It is desired to find the mathematical centre of this figure, closed by the straight line joining the headlands of the Bay.

"The mathematical centre of an irregular figure is the mid-position of its area. All mechanical centres, such as the centre of gravity or of equilibrium, etc., in which the action of any force is concerned, must be excluded from consideration.

"This will readily appear if we consider for a moment the case of a bay in the shape of a crescent. The centre of gravity of its figure would not fall upon the water of the bay at all, but upon the promontory of land embraced by the water. This, of course, could not be considered as the centre of the bay.

"Neither is any general mathematical process applicable, such as that of the method of Least Squares. This method will find the centres of any group of random spots, but were they disposed in cres-



Map Showing the Boundary Between Nicaragua and Costa Rica.

cent form, the centre would be, not among them, but within the convex space which they partially surround.

"Other methods must therefore be devised for finding the mid-position of irregular and restricted areas, and many might be suggested, more or less applicable to different figures. But it will be sufficient here to indicate only the method which I have adopted as best suited to the figure in hand, possessing, as this does, something of a curved or crescent shape.

"I have supposed a vessel to enter the Bay from the ocean, at a point midway between its headlands, and to sail a course as nearly as possible equidistant between the opposite shores, on the right and left, until it has penetrated to the remotest point of the Bay.

"This course, being carefully plotted upon the map, although curved, may be taken as the long axis of the Bay.

"At right angles to it, at different points, I have drawn straight lines reaching across the Bay from shore to shore, and, by use of a planimeter, I have determined the position of such a line which will exactly divide the whole area of the Bay into equal parts. This line may be taken as the corresponding short axis of the Bay, and its intersection with the long axis will be the centre of the Bay.

"When at that point, a line drawn across the bow of the supposed vessel, perpendicular to her course, would have one-half of the waters of the Bay in front of it and one-half behind it.

"Having carefully located the point in this manner, I have determined from the scale of the map, its distance from the summit point of the small island in the Bay, whose latitude and longitude are given upon the map as follows:

Latitude, 11° 03′ 10″
Longitude, 85° 43′ 38″

"It proves to be 37 seconds to the northward and 14 seconds to the eastward of this point.

"I therefore fix the position of the centre of Salinas Bay to be:

Latitude, 11° 03′ 47″ North.
Longitude, 85° 43′ 24″ West.

"Toward this point the boundary line must run, from its meeting with the Sapoa River, unless the two Commissions can agree upon a line with natural landmarks."

All the Arbiter's decisions were amicably received by both Republics, the questions in dispute are settled, and the boundary marked with sufficient accuracy for many years to come.

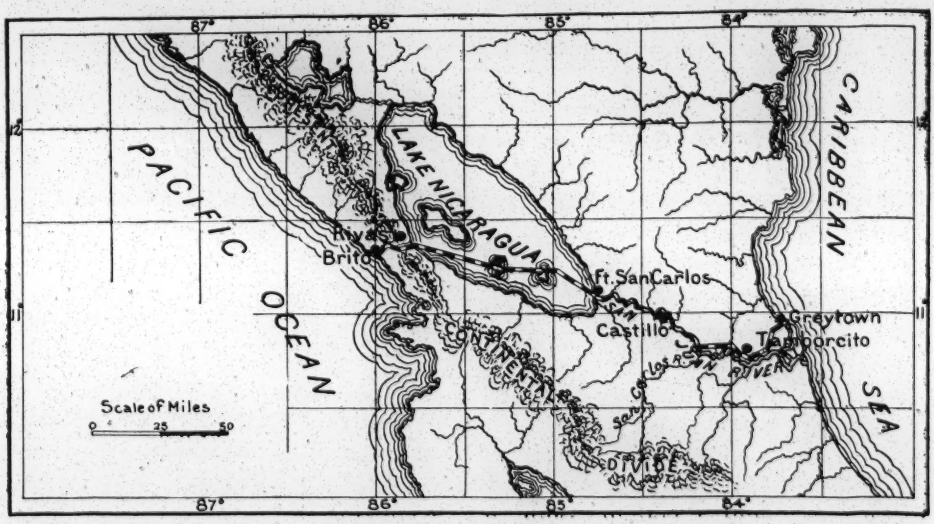
THE NICARAGUA CANAL

THE route for the Nicaragua Canal as projected by the present Isthmian Canal Commission is shown on the accompanying map. It generally follows the course of the San Juan River for one hundred miles from the Caribbean Sea to Lake Nicaragua about one hundred and five feet above it, then it traverses the lake for a distance of seventy miles to the mouth of the Rio Las Lajas, and after following the valley of that stream for a short distance, crosses the continental divide, forty-four feet above the lake, and descends the valley of the Rio Grande to Brito, seventeen miles from Lake Nicaragua.

The canal as proposed will have a mean depth at low water of thirty-five feet and a bottom width of one hundred and fifty feet. This width is for the straight sections; on curves with a radius of less than 12,000 feet the width is increased at the rate of one foot for each two hundred feet; thus a curve with a radius of 6,000 feet

will have a width of one hundred and eighty feet.

Starting from the Atlantic terminus the canal may be described as consisting of three stages: first, a period of ascent for a distance of fifty miles from Greytown till it enters the San Juan at a point about two miles above the mouth of the San Carlos River. This stage must be excavated. Second, a period of one hundred and twenty miles of high level, the level



Map Showing Route of Nicaragua Canal as Proposed by Isthmian Canal Commission.

of Lake Nicaragua, secured by means of an immense masonry dam which will extend the level of the lake fifty miles down the San Juan. This stage consists of improved river and lake channels. Third, a period of descent from the lake level to the Pacific through the continental divide. This stage, seventeen miles, must also be excavated.

The salient engineering problems connected with the Nicaragua Canal project as outlined by the Commission are as follows:

First. The construction of harbors at the termini of the canal.

Second. The excavation of the canal prism in the swamp sections between Greytown and the Florida Lagoon.

Third. The heavy cutting near Boca San Carlos and at Tamborcito.

Fourth. The construction of the large dam at or near Boca San Carlos in connection with the regulation of the summit level.

Fifth. The Locks.

Some fifty years ago there was a good harbor at Greytown, the eastern terminus of the canal, with thirty feet of water at the anchorage and about the same depth in the entrance. The entrance to this harbor where it then existed, has been obliterated and the harbor itself is now a lagoon almost entirely enclosed, of restricted area, with only about half the depth of water in it that formerly existed. Vessels for Greytown are now compelled to anchor in the offing and discharge their cargoes on lighters which are taken into the lagoon across a bar having a depth of less than six feet of water. As the prevailing trade winds are

Travelling in Nicaragua.

strong and blow almost directly on this part of the canal, the construction of a harbor at this terminus becomes necessary in the early stages of the work as well as for use after the canal is completed.

It is proposed to construct, by excavation, a harbor of sufficient area to accommodate vessels using the canal. The entrance would have a minimum depth of thirty-five feet and a bottom width of five hundred feet, guarded by two jetties springing from the shore line near Harbour Head. These jetties are to be built of loose stone to a height of six feet above mean high tide, the hearting to be composed of small and the outer portion of large stone, not easily moved by the waves. It is not expected, however, that the construction of the jetties will alone form the entrance. Dredging will also be necessary and its maintenance may require an extension of the jetties or dredging or both.

The western terminus of the canal will be near Brito. Here, as at Greytown, there is no harbor, and an artificial one must be constructed. The same general engineering principles will guide in its construction. The width and depth of the entrance will be the same. The sand movement on the western coast, however, is slight as compared with that in the vicinity of Greytown. The prevailing winds on this side are off-shore, and destructive storms seldom visit this part of the coast. The cost of maintenance of the harbor on the west side will therefore be less than that of the one on the east side at Greytown.

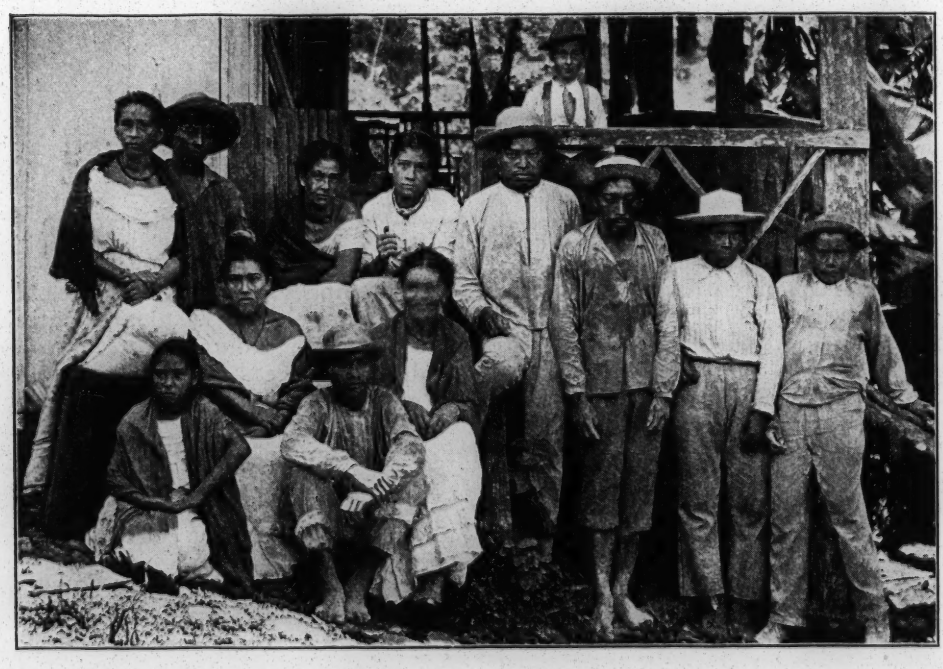
For a part of the distance between Greytown and the Florida Lagoon the canal line passes over swampy sections, where the material is too soft to support the embankments necessary to keep out the floods of the San Juan, and to maintain the canal level itself. Protecting embankments are therefore to be constructed over these sections. These embankments are to be located as far as practicable on the firm land composing the neighboring hills. In places, however, they cross ground which is soft to a considerable depth. Waterways are provided on the embankment lines to dispose of flood water in the protected areas.

At two places near the Boca San Carlos dam site heavy cutting is encountered, the maximum depth for short distances being

two hundred and eighteen and one hundred and seventy feet respectively; but the deepest cut of all is at Tamborcito, about twenty-six miles from Greytown. Here the high ground north of the canal approaches so close to the river that a cut through it becomes imperative. The ridge is narrow, however, the width at the top being only a few feet and at the level of the water in the canal less than three thousand feet, but the extreme depth of the cut is two hundred and nineteen feet. The borings show that it is nearly all hard rock. The less heavy cuts will also be in firm ground, but the exact character of the material cannot be stated until the borings now in progress have been completed.

The most difficult engineering work in connection with the Nicaragua Canal project is the construction of a dam across the San Juan River to hold back the waters of the lake and enable its level to be regulated. It is of great importance that this dam should be located above the mouth of the San Carlos River, as the latter discharges at times as much as 100,000 cubic feet of water per second, carrying with it great quantities of sand.

Lake Nicaragua, which forms a part of the summit level, is about one hundred miles long and forty-five miles wide, and is distant only about twelve to thirty miles from the Pacific. Originally it was an arm of the Pacific Ocean, but the shifting of the continental divide cut it off from the sea. The lake discharges through the San Juan River into the Caribbean Sea near Greytown. For the upper half of its course the San Juan winds through hilly country. Neither it nor any of its tributaries in this section carries much sediment, and a slack water navigation by means of locks and dams is practicable. But half way down its course the San Juan River receives the waters of the San Carlos which carry great quantities of



Natives of Nicaragua.

sand and thus render the San Juan useless for the purposes of a canal beyond their junction. The canal route, therefore, is compelled here to leave the San Juan, which can no longer be of service, and find to the sea an independent way.

Lake Nicaragua can furnish an unlimited supply of water to the canal. It is believed that it varies in its level as much as thirteen feet. Such an extreme fluctuation occurs, however, only at relatively remote intervals. This fluctuation will be reduced by the construction of the dam in the San Juan River just above the San Carlos, whose waters cannot be used because of the load of sediment they carry.

To reach the summit level from the Atlantic side five locks will be constructed, the first having a lift of thirty-six and one-half feet and the other four a uniform lift of eighteen and one-half feet, except the lock at the summit, the lift of which will vary with the level of the lake. The locks will be seven hundred and forty feet long by eighty feet wide in the clear, with a depth of thirty-five feet over the miter-sill. From the Pacific side the summit will be reached by four locks of uniform lift of twenty-eight and one-half feet. It is assumed that the mean level of the two oceans is about the same. The mean range of tides on the east is about one foot and that on the west side about eight feet.

The following table gives the distances on the Nicaragua route:

Number of miles of canal proper.....	67.33
Number of miles of river improved...	27.96
Number of miles not requiring improvement	17.26
Number of miles of lake channel 300 feet wide	22.19
Number of miles of lake not requiring improvement	48.74
Number of miles of harbors and entrances to same	3.05
Total number of miles from ocean to ocean, measured from the 6-fathom curves	186.53

Time necessary to pass through the canal, 33 hours.

The Isthmian Commission believe that it would take ten years to construct the canal, and that the cost would be at least $200,000,000.

THE TSANGPO

By JAMES MASCARENE HUBBARD

THE Tsangpo is in several respects the most remarkable river in the world. It is the highest of all navigable streams, flowing for nearly a thousand miles at an elevation of from 11,000 feet to 14,000 feet. During the greater part of its course its current is sluggish, but for a hundred miles or more the mighty river, in its descent to the coast plain, runs with the speed of a mountain-torrent. Though one of the largest of Central Asian streams, it has never been followed from its source to its mouth, and until recently it was doubtful of which of two well-known rivers it was the head-waters. The attempts to solve its mysteries have been attended with an almost unparalleled heroism, endurance, steadfastness, and self-sacrifice. For the principal explorers of the Tsangpo have been animated, not as those who sought the fountain-springs of the Nile, by the hope of the world's applause at their success —that was denied them—but for a simple daily wage and the consciousness of loyalty to duty.

The physical history of the Tsangpo is briefly this: It rises in the extreme southwestern corner of Tibet, close to the sources of the Ganges, the Indus, and its great affluent, the Sutlej, at a

height of nearly 15,000 feet. Receiving the drainage of the slopes of the Himalayas and of a little-known Tibetan range running parallel with these mountains, it soon becomes a stream wide and deep enough to be navigable. There is a considerable boat traffic upon it, at an elevation but little below the summit of Mt. Blanc. It flows due east for some eight hundred miles, receiving numerous large tributaries from both south and north, and when near Lhasa it is, at low water, nearly a third of a mile wide and twenty feet deep; in flood, two miles wide and of unknown depth. In longitude 94° E. it makes a sharp bend to the south, and passes through the Himalayas in a course known only to the savages who dwell upon its precipitous banks.

When last seen by an explorer it is at a height of from eight to eleven thousand feet, but when it emerges in Assam it is only four hundred feet above sea-level. From this point it pursues its sluggish way for another eight hundred miles as the Brahmaputra to the Ganges and the Bay of Bengal. There has been a long controversy, into the details of which it is not necessary to enter, as to whether the Irawadi or the Brahmaputra is the continuation of the Tsangpo. Though there has been as yet no direct evidence—the last expedient of throwing in marked logs in Tibet having failed—the general consensus of scientific opinion is in favor of the Brahmaputra, and the latest English gazetteer describes it under this name.

It is hardly to be expected that pure science will be much benefited by the lifting of the veil which hangs over this part of the river's course. But there can be little doubt that it hides scenes of magnificent beauty and grandeur which will thrill the expectant world, and give it new and nobler conceptions of the sublimity of nature.

The imagination fails to grasp the reality, as there is no other instance on earth of a large river dropping eight thousand feet in one hundred and fifty miles, plunging with the mad rush of a mountain-brook hemmed in by ranges whose peaks are from thirteen to twenty-two thousand feet in height. The native testimony is conclusive as to the existence of at least one awe-inspiring fall before Tibetan territory is left. A scientific journal* published, a few years ago, a copy of a picture of them by a native Tibetan artist who lived in their vicinity. It shows them enveloped in clouds of mist and spray, and the cliffs are covered by sub-tropical vegetation. The local lamas relate to the awe-struck pilgrim that amid the thundering water stands a king-devil, placed there under a spell by the lamas, and, when the river is low, the faithful can see his figure looming dimly through the falling waters.

It has not been from the lack of the spirit of adventure, or because of the natural difficulties presented by the region—great though they doubtless are—that no white man has solved the mystery of this part of the river's course. Its attempted ascent from the plains of Assam has been absolutely prohibited hitherto by the Indian Government on the entirely reasonable ground that there is almost a certainty that the explorer would be killed by the savage Mishmis, who are intolerably jealous of the presence of a stranger in their country. This would necessitate a punitive expedition costly in treasure and in life—an evil by no means commensurate with the gain of having satisfied what is, after all, pure curiosity. The Tibetan officials also, while preventing so far as they are able any white men from entering Tibet, for some unknown reason forbid Tibetans even to attempt to descend the river beyond their own frontier.

The Tsangpo has been explored, however, with the exception of this one hundred and fifty miles, notwithstand-

* Geographical Journal, vol. 5, p. 258.

ing the opposition of the Tibetans and the difficulties presented by the highest mountain region in the world, though not by white men. At any time within the last thirty-five years the trans-Himalayan traveller might have met a caravan of Tibetan and Indian traders with their pack-laden sheep climbing or descending some steep mountain-pass, or crossing the Tsangpo on rafts. Walking humbly with the servants and slaves, for to walk is a mark of servitude with those people, there would be an Indian with tea-bowl and prayer-barrel suspended at his girdle, counting his rosary as he walked, differing in nothing apparently from his companions except in his more intelligent face and the greater interest with which he noted everything about him. But open his prayer-barrel, which he piously twirls when he comes to some particularly dangerous spot, and there will be found in it, instead of the scroll with the Buddhist prayer, "Om mani padmi hom," notes of the journey after the boundary was crossed, observations with sextant and compass, and a simple route-survey showing the length of each day's march, the relative position of the prominent peaks, the course of the streams, and their approximate breadth and depth. Examine closely his rosary, and one would discover to his surprise that, instead of the orthodox one hundred and eight beads, there were only a hundred, and that he dropped one at every hundred steps, which were uniformly two and a half feet long. If he were watched carefully he would be seen to steal from camp at night, when all else were sleeping, if biting wind, freezing cold, and driving snow permit, with his box and tea-bowl. Taking from beneath the false bottom of his box a few instruments, and pouring some quicksilver into his tea-bowl for an artificial horizon, he makes an observation of some star, notes the condition of barometer and thermometer, compares his chronometer with his watch, and then goes back to camp to write up his journal, and at length to sleep. Years after, the traveller might see this same man at the Great Trigonometrical Survey in Calcutta reading to an English officer his journal, explaining his observations and route-survey, and narrating his adventures—in one instance these included a seven years' slavery in Tibet. He asks who he is, and is amazed to learn that he is only a school-master in a little Himalayan village in the district of Kumaon.

What is his reward for these year-long toils, sufferings, and dangers, this daily risking his life in an attempt to add to the world's knowledge? A little piece of land, possibly a small pension, and, while he is able to serve—oblivion. But soon the scientific journals will be full of accounts of the wonderful journey of the native Indian explorer, the great extent and marvellous accuracy of his survey, his pluck and endurance, his fertility of resource, and, above all, his single-hearted devotion to the cause of science. If his services are publicly recognized by some great Society, with the names of world-renowned explorers, we read merely, "The Pundit employed by Captain T. G. Montgomerie—a gold watch—for his route-survey in Great Tibet." *

It was in 1861 that the successful opposition of the Tibetans to the exploration of the trans-Himalayan region, by Europeans, as well as the fact that Indian traders were permitted to travel freely throughout Tibet, suggested to an officer connected with the Great Trigonometrical Survey of India the expedient of employing native surveyors.

The village school-master, Nain Singh, who had been in the service of the brothers Schlagintweit during their explorations in Kashmir, was the first man to re-

* Royal Geographical Society Year-Book, 1899, p. 208. It should be said, however, that in 1877 the patron's medal was bestowed on the Pundit Nain Singh—then incapacitated for further service. Two others are also mentioned by name in the list of recipients of awards.

ceive the necessary training for the work. At the head-quarters of the Survey he was taught the use of the sextant, compass, etc., to recognize all the larger stars, to walk with paces of uniform length, and to make a simple route-survey. When these things had been sufficiently acquired, he was sent to explore the Tsangpo from its source to India, if possible. It was 1865 before he succeeded in establishing himself in Tibet as a trader desiring to buy horses and at the same time, as a pious Buddhist, to do homage to the Lhasa Lama. His "instrumental equipment consisted of a large sextant, two box sextants, prismatic and pocket compass, thermometers for observing temperature of air and of boiling water, pocket chronometer and common watch, with apparatus, the latter reduced as much as possible." After numerous adventures he finally reached Lhasa, where he had an interview with the Grand Lama, whom he described as a fair and handsome boy of about thirteen years of age, seated on a throne six feet high, attended by two of the highest priests, each holding a bundle of peacock feathers. In this journey he was able to follow the course of the river only to the neighborhood of Lhasa, some six hundred miles. Nor did he succeed in tracing it farther in a second journey made seven years later—a journey memorable, however, from the fact that he made a route survey of 1,319 miles, 1,200 of which were through country never previously explored, and took four hundred and ninety-seven observations. During all this time he was known to the scientific world only as the "pundit," but the sufferings of this last journey having so affected his health as to compel him to give up his connection with the Survey, his name was disclosed. He has been followed by others, among whom those known as A—k, D—m—g, and K. P. have accomplished the most in trans-Himalayan exploration, all men of like courage, endurance, and animated by a single-minded devotion to their duty. But none have succeeded, as yet, in tracing the Tsangpo's course through the mountains to Assam.

But there are indications of a change of feeling of the rulers of Tibet toward the Indian Government which promises free intercourse between the two countries in the not distant future. As the deadly hostility of the Mishmis to strangers penetrating their mountain fastnesses has been largely due to Tibetan influence, we may look in time to a similar change among them to friendliness. If this should be the case, we trust that the man who lifts the veil which shrouds this wondrous passage of the river through the Himalayas may be one of that noble band, a native Indian surveyor.

RECENT CONTRIBUTIONS TO OUR KNOWLEDGE OF THE EARTH'S SHAPE AND SIZE, BY THE UNITED STATES COAST AND GEODETIC SURVEY.

By C. A. SCHOTT

THE Survey has just published a quarto volume containing an account of the transcontinental triangulations and measurements of an arc of the parallel in latitude 39°. It also has ready for publication the manuscript giving the result of an oblique arc in the eastern part of the United States. Both are contributions of great length and among the first of their kind in America.

At first sight it might appear rather late in the history of the Survey to bring out results of the earth's figure. But it should be remembered that such measures were not the prime object of the Survey in its early stages of activity, but came about in the natural course of continuous development during nearly two-thirds of a century. What was required was to secure a series of geodetic measures consistent within themselves and serving as a bond binding together the separate detail surveys so as to form ultimately a systematic whole. This requirement demanded the establishment of extended primary triangulations not only along our coasts, but also as a connecting link across the country from ocean to ocean, to secure uniformity of results. The growth of these operations depended of course upon the immediate requirements of the Survey for the production of harbor and coast charts and was subject to the means available from year to year.

Thus when I state that the first was made between the years 1844 and 1898, and the second between the years 1833 and 1898, I do not mean that it took fifty-four and sixty-five years respectively to complete the task. Indeed, in either case there were many years of interruptions. What these long intervals signify and emphasize, is, that the various operations of the Survey were more urgently required in the production of practical results for immediate use and in a great measure as aid to navigation. For the more technical part of the work the available knowledge of the earth's magnitude was sufficient for the early needs. At the same time it was recognized that the measurement of the earth required the same means and methods as that of an extended country, viz., a net-work of primary triangulations and a number of astronomical determinations for latitude, longitude, and azimuth of its points. In time, therefore, sufficient material would accumulate to direct special attention to this, the highest feature of geodesy.

After the triangulations had reached hundreds of miles in extent, and the geographical positions had been determined by their development upon the surface of a spheroid representing the shape and size of the earth, it became a matter of importance to see that the direct astronomical measures for latitude and longitude kept in close accord with the corresponding geodetic measures; thus it came about that in February, 1880, the Survey changed its first reference spheroid, that of Bessel, for a more suitable one, that of Clarke of 1866.

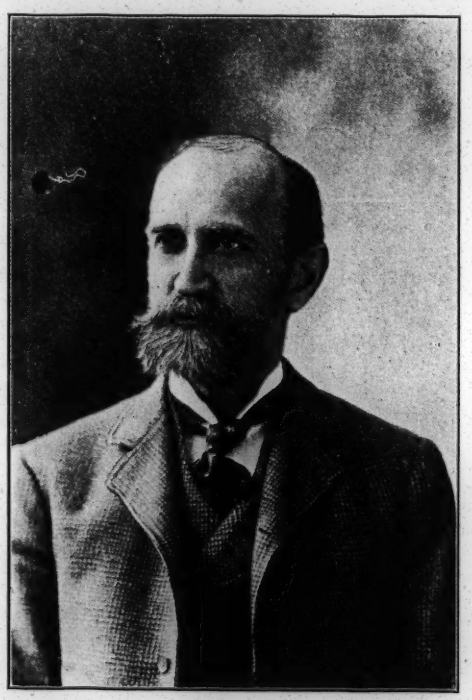
When in 1889 the United States, by resolution of Congress, consented to become a member of the International Geodetic Association for the measurement of the earth, the subject of the measures of

arcs came into greater prominence, and thus the field work of the two arcs, then fairly under way, was accelerated and brought to a close late in the year 1898.

Before entering upon the detail of the two arcs it may not be out of place to state that in order to obtain a measure of the dimensions of the earth, as represented by a spheroid, that is, by a surface generated by the rotation of an ellipse about its minor axis, it is essential that we should be in possession of at least two arcs or of an equivalent thereof. For combinations of two arcs of the meridian, their mean latitudes should differ widely; the same is true for the combination of two arcs of the parallel. We may also obtain an arc of the meridian with one of the parallel, but in every case the measures should be of considerable extent. Arcs of less than 5° (about 556 km., or 345 st. miles) would now be regarded as short ones. It has been stated that one of our arcs is an oblique arc, and as it possesses a great range of latitude and also of longitude and is supplied with a large number of astronomic measures, it is of itself sufficient for the deduction of values for the dimensions of the earth. Furthermore, it may be remarked that for any relatively small part of the earth's surface an osculating spheroid may be determined, as, for instance, was done for our oblique arc. Such a spheroid has the property that its surface is in best accord, as regards curvature, with the actual or physical one, the latter considered as a mathematical surface of equilibrium and generally known as geoid.

The definition of an osculating spheroid thus implies that the sum of the squares of the difference between the various astronomic and geodetic measures be a minimum. The mathematical treatment of the combination of the arc measures differs according to their nature, whether they are extended in a certain direction or whether large areas are covered, but in its generality it is necessarily laborious.

The salient points of the two arcs under consideration and the results reached may now be briefly stated. First, the arc of the parallel in latitude 39°.* It extends from Cape May, N. J., on the Atlantic coast, to Point Arena, Cal., on the Pacific coast, and ranges over 48° 46′ of longitude, with a linear development of about 4,225 kilometres, or 2,625 st. miles. The triangulation is supported by ten base



O. H. Tittmann, Superintendent, U. S. Coast and Geodetic Survey.

lines with an aggregate length of 53½ st. miles, the longest or Yolo base being 10.9 miles in length; one-half of these lines having a smaller probable error of measure than one part in a million. A

*U. S. Coast and Geodetic Survey; H. S. Pritchett, Superintendent. The Transcontinental Triangulation and the American Arc of the Parallel. By C. A. Schott, Assistant, Coast and Geodetic Survey, Washington, D. C., 1900.

characteristic of the triangulation is its rigidity imparted to it by quadrilaterals and other polygons. In crossing the Rocky Mountains many of its sides exceed one hundred miles in length, and there is one side reaching to a length of 294 km., or 183 st. miles; the altitude of many of the stations is also considerable, reaching to 4,300 metres, or 14,108 feet, in the case of Pike's Peak, and to 14,421 feet at Mount Elbert. All geometrical conditions subsisting in the triangulation are satisfied by adjustment, inclusive of the required accord of the base lines, so that the same length for any given line is found no matter from what line one may start. This involved much heavy work; for instance, the triangulation adjustment between the Salina and the El Paso base demanded the simultaneous solution of ninety-nine normal equations (with as many unknowns). In addition the figures required the evolution of a correction to each of the two hundred and twenty-five observed directions.

Coming to the astronomical measures, we have distributed over or near the arc one hundred and nine latitude stations, occupied almost exclusively with zenith telescopes; there are, also, seventy-three azimuth stations, various methods having been used, and lastly we have twenty-nine telegraphically determined longitudes. These, of course, are of paramount importance for an arc of the parallel. There cannot be too many longitude stations in consequence of that great stumbling-block in geodesy, the local deflections of the vertical or plumb-line. These deflections of the zenith from a normal direction have been divided into two groups: Those which are regional or manifest themselves with marked common features over thousands of square miles, and those which are quite local and greatly depend upon the surface features immediately surrounding them.

These deflections, even in level countries, average about 2.5″; but in mountainous regions this deflection is greatly surpassed. Thus we find for deviation of the plumb-line at Patmos Head station 12″ to the north, at Colorado Springs 25″ to the west, at Salt Lake City about 17″, and at Ogden about 15″ to the east, at Genoa Station, Nev., nearly 29″ to the west, the quantities depending to some extent on the spheroid of reference; but their amount and direction are obviously well accounted for by the position of the known attracting masses. In connection with this, continental attraction may manifest itself and be recognized by the astronomic amplitude of the longitudes of extreme stations of a long arc being in excess of the corresponding geodetic amplitude. The matter cannot be further pursued here in detail, but it may suffice to state that the average curvature of the equipotential surface of the geoid along the parallel of 39° approaches for about four-sevenths of the arc from its eastern

A NOTE CONCERNING THE CHART ON THE OPPOSITE PAGE

THE value of the Chart of the World, shown on the opposite page, is that the areas of all parts of the world appear in true proportion.

The projection is the invention of Professor C. B. Mollweide, in 1805; numerous applications of it were made by Babinet in 1857, which gave rise to his name being attached to it under the designation Babinet's homolographic projection. It is an equal surface projection in which the entire surface of the earth is represented enclosed within an elliptic outline, whose major and minor axes represent the equator and central meridian respectively, with a ratio of 2 to 1. The parallels are straight lines, and the meridian, ellipses, and each zone or subdivision of the projection is in due proportion to the corresponding area on the sphere. The distances of the parallels from the equator-line are computed from the formula characteristic of the projection. C. A. S.

PRINCIPAL ARCS OF THE MERIDIAN, THE PARALLEL AND OBLIQUE ARCS.

FOR THE MEASUREMENT OF THE EARTH'S FIGURE AND SIZE.

MAP ON
MOLLWEIDE'S EQUIVALENT
OR HOMALOGRAPHIC PROJECTION

ARCS
MEASURED
IN PROGRESS
PROJECTED

end closely to that of the Clarke spheroid; whereas, for the remaining three-sevenths, or for the region across the Rocky Mountains to the Pacific, the curvature comes more nearly to that of the Besselian spheroid. In the published paper two tables are given containing the results needed for combination with any other arc and, in conclusion, some preliminary rough combinations of American arcs are presented; all of which point to a reference spheroid of larger dimensions than those of the Besselian and are in favor of continuing the use of Clarke for reference.

The second arc under consideration extends from Calais, Me., in the northeast and opposite the Canadian boundary, to the Gulf of Mexico, and terminates at New Orleans, La. It is known as the Eastern Oblique Arc of the United States. Its length is 2,612 km., or 1,623 statute miles; its difference of latitude is 15° 1′, and of longitude 22° 47′. The general direction is, therefore, favorable and the length ample to secure fair results for an osculating spheroid. In the main the triangulation follows the Appalachian chain of mountains; in Western North Carolina and Eastern Tennessee it bifurcates, leaving an oval space between the two branches. The length of sides depends upon six base lines, and in general the development is closely accommodated to the hypsometric and other natural conditions along the course. It includes among its stations the two highest points in the eastern part of the United States, viz., Mount Washington, N. H., rising to about 1,920 metres, or 6,300 feet, and Mount Mitchell, N. C., rising to about 2,038 metres, or 6,687 feet.

The adjustment of the whole triangulation is effected precisely as explained in the use of the arc of the parallel; the small reduction to the sea-level of the observed horizontal directions, on account of the altitudes sighted, was only applied when exceeding 0.05″. The principal labor of adjustment was demanded by the necessity of bringing into accord the measured lengths of the Fire Island, the Massachusetts and the Epping base lines, and fulfilling the geometrical conditions of the intervening net of triangles. This demanded the satisfying of fifty-seven conditions and involved the simultaneous solution of an equal number of normal equations and the working out of one hundred and thirty-one corrections of observed directions. Of astronomic measures we have seventy-one latitude stations, seventeen longitude stations, and fifty-six azimuth stations, tolerably well distributed over the whole extent of the arc. The latitudes, as were those of the arc of parallel, were corrected for height of station or curvature of the vertical and for variation of pole according to Dr. Chandler's and Dr. Albrecht's researches. The same scrutiny as before had been extended to the deflections of the vertical, both regional and local. Partly on account of avoiding unnecessary labor, but principally on account of the crowding together of astronomic stations in certain very limited localities, and all of them, therefore, partaking of the deflections characteristic of this area, the total number of astronomic stations admitted into the final equations for the determination of the best spheroid were thirty-six for latitude, fourteen for longitude, and thirty-four for azimuth, or eighty-four conditions in all.

These eighty-four differences between the astronomic and geodetic results constitute the data needed for a new determination of a spheroid; next the functional relations between the positions of these stations upon the reference spheroid to the earth's equatorial radius and to the compression of the polar axis had to be established.

The final normal equations contain, therefore, four unknown quantities, viz.: the correction to the meridional deflection of the vertical at the initial or reference station of the oblique arc; second, the corrections to the deflection of the ver-

tical, in the plane of the prime vertical, at the same place; third, correction to the equatorial radius of the reference spheroid; and, last, the correction to its compression.

In the combination of conditional equations arising from observations of a different nature, the question of their relative weights must be considered. In the present case, four assumptions were made and the consequent normal equations solved, viz.: for equal weights, for weights one-half, one-third, and one-fourth to the azimuth equations, the latter being necessarily inferior to the equations derived from latitudes and longitudes. A comparison of these four results showed that it was of small consequence which of these hypotheses was finally adopted, since the corrections to the equatorial radius of the reference spheroid were practically the same for any of these hypotheses, and nearly the same could be said of the resulting compressions. The weight one-third to each of the azimuth equations was finally decided upon, and the resulting dimensions of an osculating spheroid were found to be: Equatorial radius, 6,378,157 ± 90 metres; compression, 1/304.5 ± 1.9. The equatorial radius, therefore, differs but forty-nine metres from Clarke's value of 1,866 adopted on the Survey, while the Besselian value is apparently too small by eight hundred and nine metres. On the other hand, the compression or the ratio of the difference of the equatorial and polar semi-axes to the former is in favor of Bessel's spheroid, of which the compression is 1/299.2; that is, one more closely approaching a sphere.

In the present state of our knowledge there is no reason to suppose that the curvature of the northern part of America differs any more from that of a general spheroid derived from arcs of all kinds so far measured than local ones in either hemisphere differ among themselves. A comparison of a number of such locally adopted spheroids will bring to evidence the local deformities in the shape of the earth's equilibrium surface and furnishes the geodesists endless material for the study of the earth's actual figure.

The manuscript concludes with a comparative table of the dimensions of several spheroids which of late have come more into prominence. It is as follows:

Spheroid of	Equatorial radius, a, in metres.	Polar semi-axis, b, in metres.	$a-b$.	Compression $(a-b)/a$.
Bessel, 1841. From ten arcs of the meridian and total amplitude 50° 34′	6,377.397	6,356,079	21,318	1/299.15±3.15
Clarke, 1858. Special spheroid for surface of Great Britain and Ireland; range of latitude 12°, the same in longitude; seventy five astronomic stations	6,378,494±90	6,355,746	22,748	1/280.4±8.3
Clarke, 1866. From five meridional arcs, of total amplitude 76° 35′	6,378,206	6,356,584	21,622	1/295.0
Clarke, 1880. From five meridional arcs and longitudinal measures, total amplitude 88° 59.8′ (equatorial degrees)	6,378.249	6,356,515	21,734	1/293.5
United States Coast and Geodetic Survey, 1900. Eastern oblique arc of the United States; total length, 23° 31′, and eighty-four astronomic stations	6,378,157±90	6,357,210	20,947	1/304.5±1.9
Harkness, 1891. From "The Solar Parallax and Related Constants," Washington, 1891, p. 138. From a variety of sources	6,377,972±125	6,356,727±99	21,245	1/300.2±3.0

N. B.—The ± indicates probable errors.

EXPLORATIONS IN CENTRAL EAST AFRICA

DR. DONALDSON SMITH has returned to Philadelphia from a journey of 1,500 miles through Central Africa, from Berbera, on the Somali coast, to the Nile via Lakes Rudolf and Stephanie; the last half of the journey was over new country never before explored.

After considerable difficulties with the local officials, which involved the fitting out of three distinct expeditions, Dr. Smith started from Berbera on August 1, 1899. Owing to the desertion of his Sikh followers, he began to cross the Haud with only seventeen Somalis and as many Gurkhas and Sikhs, besides his assistant, Mr. Frazer, and a Goarnese cook. The expedition marched by way of Milmil, Sesahane, and Sheneli to the Shebeli River, the followers being increased to forty-eight on the way. The Shebeli was reached on September 8th at a spot called Godi, over four hundred miles from Berbera by road, and on September 11th the expedition started west again, and between Gohulle and El Dere followed the line of march traversed by Dr. Smith in 1895.

In the first journey he saw the worst side of the Abyssinian method of annexation, but his more recent observations showed him that the Abyssinians' treatment of tribes once brought thoroughly to submission was commendable. In the first attacks the Abyssinians were certainly very cruel, but later they restored to the natives a large proportion of their belongings and very nearly their original self-government, only a moderate tax being imposed. From the Somalis to the Boran he was surprised to find the natives quite as rich apparently as they were before they came under Abyssinian rule.

Leaving El Dere, which is about equidistant (750 miles) from Berbera and the Nile, the expedition marched through broken and very wooded country, abounding in elephants, and here the Somali followers gave much trouble. They were never satisfied unless they had over ten pounds of camel meat or mutton a day each, and when food was scarce Dr. Smith had to be on the alert constantly to prevent them from poisoning transport animals or stealing sheep. But the Somalis were not such miserable thieves as most of the Indians, and their superb physical condition, swift-footedness, endurance, and intelligence were remarkable. Of the nine Gurkhas four only were pure blooded, and these were among the best men in camp. But the others, with some of the Sikhs, continually tried to hide if the march were long, and had to be hunted up. Two who evaded the search parties were never heard of again.

After leaving Goff, the expedition reached an altitude of over 5,000 feet in the Boran highlands, when suddenly the caravan was brought to an abrupt halt by a precipice that sheered off almost perpendicularly to a broad plain 1,700 feet below. Five marches were occupied in crossing this plain, where Dr. Smith obtained a specimen of a tiny gazelle which had been proved to be new to science.

On November 26th the valley of Lake Stephanie was entered, and here the expedition endured much hardship by the burning of the camp and the shortness of water, for the water of the lake was found to be so briny that it was undrinkable. Lake Rudolf was reached on December 10th. The formerly rich tribe of Rusia was found no longer to exist, and no human beings were seen until the river Nianam was reached.

A remarkable change in the fauna was now observed. Between the Nianam and the Nile there was not only a completely different set of birds, but scarcely any of

the mammalia were the same as had been found in the eastern section of the journey. On January 3d the Omo River was left behind. It was now found that as the expedition approached, the natives fled to the hills and seemed inclined to fight. They appeared to be a branch of the Turkana. One day a number of them attacked two of Dr. Smith's camelmen, and were only driven off by firing; but this was the only case of attempted hostilities on the whole journey.

After leaving the highlands and crossing at right angles the line of march of the late Captain Wellby, the Magois were encountered. They have the heavy build and large features, with high cheek-bones, of the Soudanese, and, above all, the lines of raised tattooing on their cheeks that is so typical of the people about the Nile. Dr. Smith thinks it not unlikely that they are a branch of the Dinkas, who, perhaps being driven from the Sobat by the Neurs, put the desert between themselves and their persecutors. They seem to care principally for small red beads, and work them in gorgeous patterns on leather plaques, with which the warriors adorn their massive dead-dresses.

The most *outré* of our fashionable young men can never aspire to the height of collar worn by some of the Magois. Their collar of beads throws the chin high up in the air, and their locks are done up in a great chiffon, composed principally of clay covered with ostrich feathers. Parallel lines of raised tattooing on the chest and abdomen, leopards' skins hung over the back, and a bell hung on a slender cord around the waist help to enrich the men's apparel. They are the only people Dr. Smith has ever seen wearing a zebra's tail suspended from the elbows. Many of the younger girls have rather attractive features and pretty figures. The worst burden they have to carry in life seems to be the countless necklaces of beads which spread over their bosoms to the waist, and the large bracelets and anklets of ivory, brass, and iron. Their hair is shaved above the ears and cut fairly close on the top of the head.

Contrary to the advice of these natives the expedition set out into the plain westward, and here they suffered much from the difficult ground and the scarcity of water, and many transport animals and much valuable baggage were lost. After searching for a better route for many days, a branch of the Magois calling themselves Katua were encountered, and Dr. Smith was surprised to find them cow-worshippers, indulging in certain rites supposed to be peculiar to the Hindu religion. On reaching the most northern extension of the Uganda highlands on February 15th, the Akara were met with. Many of these natives were agriculturists as well as stock-raisers, and had substantial wooden dwellings. Villages were passed which might easily have contained 1,500 inhabitants. Dr. Smith secured at this stage of the journey the only specimens ever obtained of the spotted bushbuck. On March 2d Lockall was reached, and there Dr. Smith received a visit in state from King Amara, who commanded perhaps 25,000 warriors. Fort Berkeley was reached on March 14th last. As no steamers had come up, however, the followers of the expedition had to be sent down to Mombasa after waiting a month. But on May 5th a gunboat arrived and Dr. Smith and his collections were carried down to Cairo. That site was reached just ten months after the departure of the expedition from the Somali coast.

Dr. Donaldson Smith has not only thoroughly explored a large tract of Africa, but he has made a most valuable series of surveys and some very interesting collections. Dr. Smith has earned a very high position as an explorer of unknown countries, and deserves the warmest praise of geographers.

GEOGRAPHIC NOTES.

THE DUKE OF ABRUZZI.

THE Duke of the Abruzzi will despatch from Christiania in the spring a relief party to search for the three members of his North Polar expedition who were lost in March, 1900. These were Lieutenant Querini, a Norwegian engineer, and an Italian machinist. Captain Cagni's party set out from Teplitz Bay, 82° 4′, where the *Stella Polare* was blocked, March 11th, and during the first nine days advanced 43.5 miles. As the party was too numerous for rapid advance, he determined at this point to send back the three men whom he judged were least able to stand the strain of marching. It had been agreed when Cagni and the Duke separated that only those most enduring and competent should continue with Cagni on the march. The three were started back in good spirits, good health, and abundantly provided with provisions, but they were never heard from again. Captain Cagni believes that they must have fallen into a chasm and perished. Letters were left at Teplitz Bay with instructions for the men to proceed to Cape Flora. Provisions sufficient for twenty men for three years were also left with the letters and enough more for three men for four years at Cape Flora.

Lieut. Franco Querini.

The preliminary report of the expedition recently published by the Duke of Abruzzi in the Italian *Militare e Marina* has added but little to the account already given in the NATIONAL GEOGRAPHIC MAGAZINE (vol. xi., pp. 411–413). The advance of Cagni is especially remarkable for the speed which his party was able to maintain. For days they averaged 9.5 miles in twenty-four hours, a phenomenal rate of advance over polar ice and snow. Latitude 86° 33′ was reached April 26th. No land was here in sight, nothing but ice in a state of thaw. Petermann's Land, which Payer believed he saw, did not exist where he stated or Cagni would surely have seen it early in his journey. The same must be true of King Oscar Land.

TRANS-SIBERIAN RAILWAY.

WORK will be resumed on the branch of the Trans-Siberian railway from Stretensk to Khabarovsk. This route was abandoned for a more direct line to the Pacific through Manchuria when Russia acquired

practical control over Manchuria after the Chino-Japan war. The disturbances in this province during the past summer have shown the Russian Government that for a number of years the route through Manchuria is liable to be cut by bands of Chinese at any moment. Hence if there is to be regular railway service from St. Petersburg to the Pacific a safer route must be maintained. The northern route, which is a part of the original plan, follows the left bank of the Shilka and Amur Rivers and thus keeps entirely in Russian territory. It protects and is in turn protected by the line of Russian steamers and barges which regularly ply up and down the Shilka and Amur between Stretensk and Khabarovsk.

NATIONAL GEOGRAPHIC SOCIETY LECTURES.

THE National Geographic Society announces the following lectures: "The Explorations and Missions of the Franciscan Fathers in Mexico," by J. Stanley-Brown, Friday, January 4th; "The Routes for an Isthmian Canal," by Arthur P. Davis, Friday, January 18th; "The Characteristics, Recent Progress, and Present Condition of Mexico," by Señor Dr. Don Juan N. Navarro, Mexican Consul-General at New York, Friday, February 1st. These lectures are held in the Congregational Church, at eight P.M. Technical meetings for the reading of papers and general discussion will also be held on the evenings of January 11th and 25th. The place of meeting and subjects will be announced later.

SVEN HEDIN.

IT was feared that Sven Hedin had lost his life in the chaos throughout the Chinese Empire during the past summer. But he has reached his headquarters, Yangi-Koll, Central Asia, safe and sound, and is as enthusiastic and vivid in his descriptions as ever. He reports that he has passed the summer, unmolested, in the vast Desert of Gobi.

It will be remembered that Sven Hedin went to Central Asia in August, 1899, purposing to stay three years there verifying and continuing the explorations he made in that region during 1893–1895. His narrative of those years, *Through Asia,* has been published in half a dozen languages, and has made him world-famous as one of the great explorers of history, comparable to Marco Polo, von Richtofen, and Livingston.

Dr. Hedin writes that he has definitely located the original bed of the mysterious and shifting Lake Lobnor, about the location of which geographers have so long wrangled. Along the south end of the lake once ran the ancient caravan route from Central China westward, formerly thronged with camels carrying silk to the markets of the west. On the banks of Lake Lobnor were found the ruins of houses, temples, and watch-towers, evidently the remains of a city rich and prosperous 2,000 years ago. The rivers in that region are very perceptibly drying up at their southern ends, Dr. Hedin states, and growing bigger and bigger at the north. He concludes that the hydrographical system is moving toward the northeast.

THE COAST OF PORTO RICO.

THERE was no relaxation in the activity displayed by the United States Coast and Geodetic Survey in its surveying operations in Porto Rico during the summer of 1900. During the season thirty-six triangulation stations were occupied and one hundred and one geographical positions located. A base line was measured and an azimuth determined. Large scale surveys were made of the approaches and surroundings

of Guanica Bay and Mayaguez, and a small scale survey of that portion of the main mountain range visible from the south coast. The difficulties of the work may be imagined when it is stated that for several hours each day, for nearly three months and a half, it was necessary for the topographer and his aids to work in water almost waist deep.

THE CENSUS OF INDIA.

THE third general census of India will be taken on the night of March 1st. Ten years ago the population of India was about 287,000,000, but this census will probably show not more than 300,000,000, as the ravages of famine and cholera during the past decade have been great. In other words, the increase of population in India during 1891–1901 is estimated at about the same as the increase in the United States during the same period, though the latter had less than one-fourth as large a population as the former. The immensity of the task involved in counting the people of India, one-fifth the population of the world, may be grasped by comparison with the immense work of taking a census of the United States. Nearly a million men and boys will be employed as enumerators, clerks, etc. The well-known suspicion and reluctance of the Indian people to answer the questions of the census taker are gradually wearing away, and the Indian Government confidently hopes for good results from the census of 1901.

LAKE TANGANYIKA.

CONVINCING evidence of the shrinking up of Lake Tanganyika was presented in a paper recently read in Brussels by Captain Hecq. The post of Karema was built twenty years ago on the shores of the lake, but when Captain Hecq last visited the place, a few months ago, the waters had so receded that the post was fourteen miles distant from the lake. The slave-trade in the vicinity of Lake Kivu is dead. Domestic slavery, however, Captain Hecq states, still continues, but will soon disappear.

A REPUBLIC IN MANCHURIA.

A FLOURISHING little republic in Manchuria, it is asserted, has been discovered by the Russians. It lies along the upper reaches of the Sungari River, below Kirin, which is on the line of railway from Onon to Port Arthur. The Government, according to report, is properly organized with a President, Courts of Justice, Trade Guilds, tax collectors, and other officers of a State. It supports a small army, which last summer joined the Chinese forces to oppose the Russian advance, and fought with much valor. Probably the Republic was founded seventy years ago. It now numbers about 100,000 and, oddly enough, has always been favored by the Imperial Government.

ORGANIZATION OF FRENCH CONGO.

BY a recent decree of the French Government a new administrative province has been formed in North Central Africa, entitled "Territoire Militaire des pays et protectorats du Tchad." It includes the basins of the Kemo, a tributary of the Ubangi, and of the Shari, and also Wadai, Bagirmi, and Kanem, which by the Anglo-French agreement of 1899 were included in the French sphere of influence. The object of this organization is to enable France to cease sending military expeditions to this region. All the soldiers henceforth of this province will be natives, officered, of course, by Frenchmen.

THE FORESTS OF THE PHILIPPINES.

THE Philippine Bureau of Forestry has submitted its first report on the forest wealth of the Philippine Islands.

The Bureau was organized by order of the Military Governor, April 14, 1900, to ascertain the condition of the forests and the regulations adopted by the Spaniards for their preservation.

It is estimated that from one-fourth to one-half the area of the Philippine Islands, or from twenty to forty million acres, are public forest lands. In the islands of Mindoro and Paragua at least 5,000,000 acres of virgin forests are owned by the State.

The island of Mindanao with an area of 20,000,000 acres, is almost entirely covered with timber. Even in the province of Cagayan, Luzon, there are more than two million acres of forests. In some of the southern islands magnificent tracts are standing with from 10,000 to 20,000 cubic feet an acre of splendid timber. The trees tower to a height of one hundred and fifty feet, often shooting up sixty feet without a single branch and of a diameter of four feet.

Captain Ahern, Director of the Bureau, believes that there are as many as five hundred species of trees in the archipelago. No pure forest of any one species exists. Rarely do more than three or four trees of one variety grow together. Many varieties of valuable gum, rubber, and gutta-percha trees are found; also seventeen dyewoods and the ylang ylang from whose blossoms so many perfumes are made.

It is stated the regulations adopted by the Spanish for the preservation of the forests of the Philippines were in line with the most advanced forestry legislation of Europe. But these rules were not enforced. The men licensed to cut, hewed indiscriminately; with the result that the most valuable rubber, gutta-percha, and ylang ylang trees were used for firewood. The old regulations have been revised by Captain Ahern. Lumbermen are now licensed to cut only certain species.

SOUTH POLAR EXPLORATION.

THE arrangements for the British and German South Polar Expeditions which sail from Europe in August, 1901, are nearly completed. It is expected that the English boat, the *Discovery,* will be launched in March at Dundee. She is a good strong boat, built on different lines from the *Fram,* for the latter was planned to resist, or rather escape, tremendous ice-pressure, while the *Discovery* was modelled to withstand the attacks of a boisterous sea. The German boat, building at Kiel, is smaller and lighter than the *Discovery* and follows somewhat the lines of the *Fram.*

The two ships sail from Europe together. The official statement of their plan of co-operation is as follows:

"When they reach the far South they will separate with a carefully arranged plan of work for each. The Antarctic regions have been divided into four quadrants. First, the Victoria quadrant, which extends from 90 degrees east to 180 degrees, and includes Victoria Land; second, the Ross quadrant, from 180 degrees to 90 degrees west, south of the Pacific Ocean; third, the Weddell quadrant, from 90 degrees west to 0 degree (Greenwich meridian), the Weddell Sea; and fourth, the Enderby quadrant, from 0 degree to 90 degrees east, which includes Enderby Land. Two quadrants have been assigned for exploration and research to each expedition, the British taking the Victoria and Ross, and the German the Weddell and Enderby."

Both expeditions hope to be able to spend three years in the work. Captain Drygalski, the famed explorer of Greenland, leads the German party, while Captain Scott of the British Navy, young, hardy, and level-headed, directs the English.

THE PRINCIPLES UNDERLYING THE SURVEY OF THE BOTTOM OF THE OCEAN FOR AN ALL-AMERICAN TRANS-PACIFIC CABLE TO THE PHILIPPINES AND THE ORIENT.

THE object of such a survey is so to develop the mountain systems of the bottom of the ocean that every large change of elevation will be disclosed and allowed for in the laying of the cable; and the problem therefore is to determine the intervals at which deep-sea soundings should be taken in order that important mountain systems may not escape detection and subsequent development.

The survey consists of two main parts: first, direct lines of soundings spaced at alternate intervals of ten and two miles passing between the successive landing stations at Honolulu, Midway, Guam, and Luzon, and also between Guam and Yokohama in Japan; and secondly, of sounding stations, twenty miles apart, at the turning points of a zigzag route passing back and forth to equal distances on each side of the direct lines of soundings.

The direct lines were run in passing to the westward from California to the Orient, and they give the general contour of the bottom. The zigzag lines were run in returning to the eastward for the purpose of giving breadth and configuration to the forms indicated as a result of the depths measured along the direct lines. This distribution of soundings was adopted as a result of a theoretical investigation giving the equation to the curve which, by revolution around a vertical axis, would generate the surface of an isolated submarine peak in which the crushing strength at any cross-section is equal to the combined weight of the formation above that section and of the superincumbent body of water.

Taking the origin of co-ordinates at the apex of the peak, and the axes of y and x to be vertical and horizontal respectively, the equation to the generating curve would be $y = \frac{\kappa}{\delta} + \frac{2\delta'}{\delta} \log x$, in which κ represents the coefficient of crushing strength of the materials composing the crust of the earth, δ the average density of these materials, and δ' the density of sea-water. The shape of the formation thus described resembles the form of the Eiffel Tower, but is much flatter in proportion to its height.

From the investigation of its properties it appears that the radius which a prominent orographic feature can have at the sea-bottom may be stated to be ten miles. An interval of ten miles coupled with an interval of two miles is the very longest that would be sufficient for general development, but these intervals are small enough to prove with certainty the existence or absence of any formation rising close to the surface of the deep sea.

Of all the possible ways in which a ten-mile interval could lie with reference to a submerged peak, that which would be most advantageous for a prompt discovery is the condition in which one end of the interval is at the bottom of the slope and the other near the apex, and that which would be least advantageous is the condition in which the interval is bisected by the position of the apex. In the latter case there would be nearly equal soundings at both ends, but the soundings at the ends of the adjacent two-mile intervals would immediately disclose the slopes.

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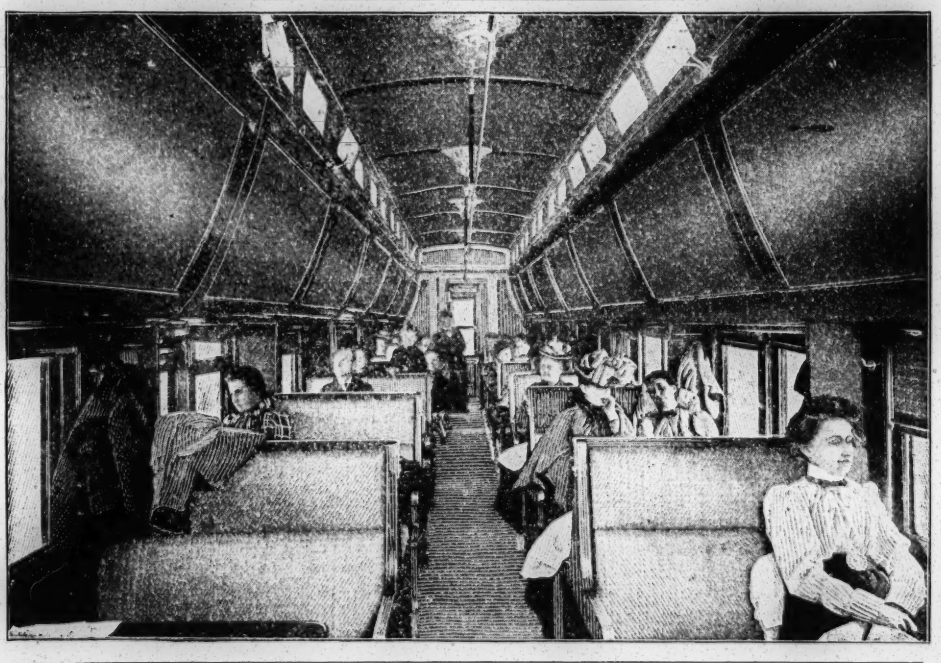

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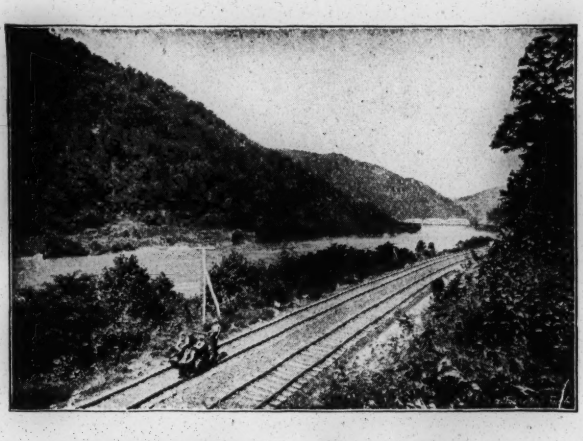

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